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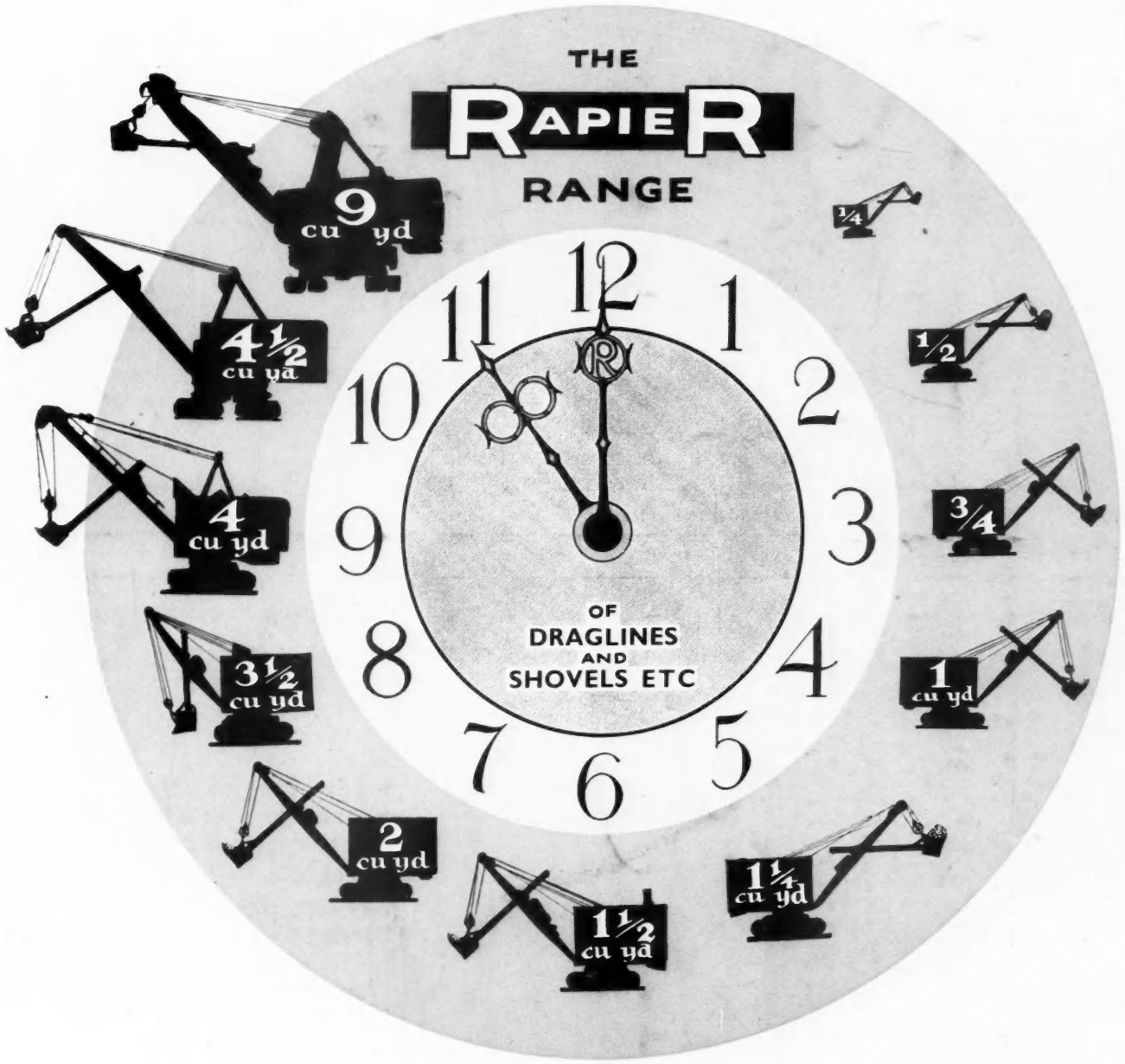

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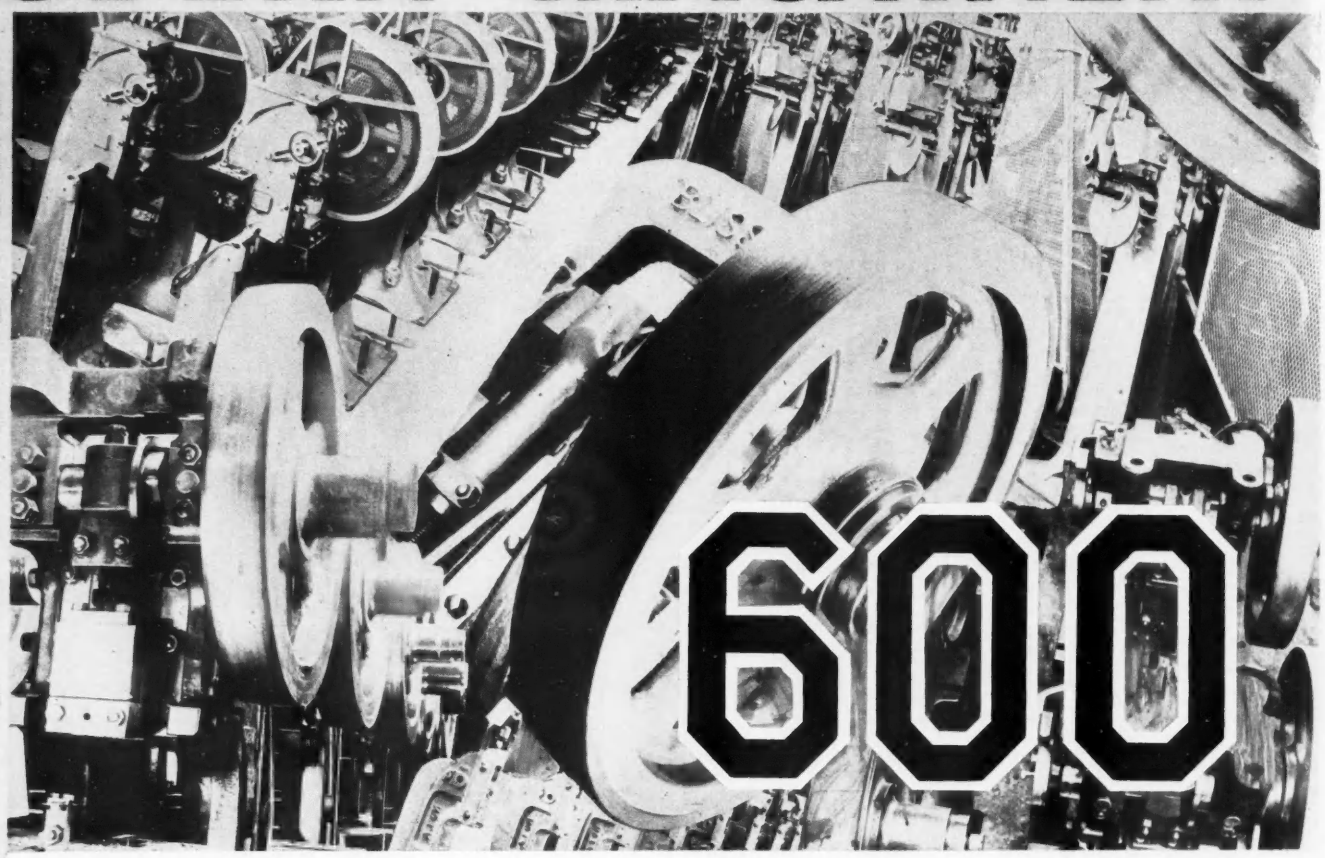

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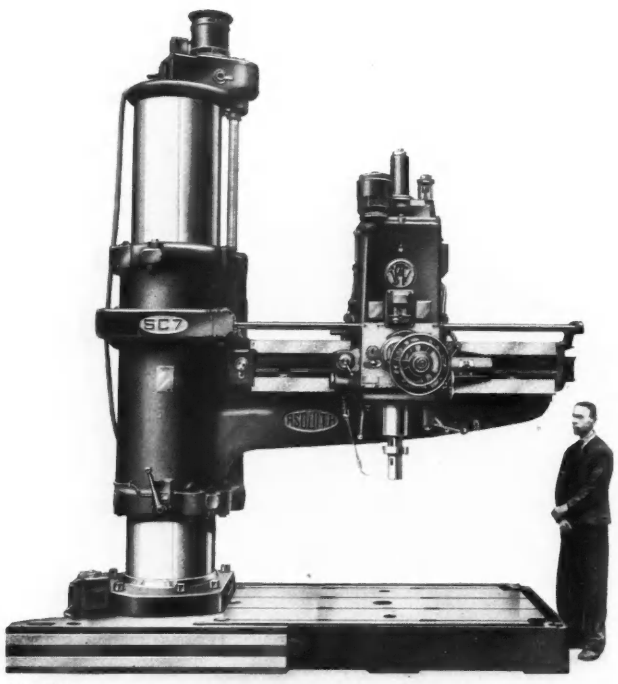

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A Seven-Day Journal

The British Electrical and Allied Manufacturers' Association.

PRESIDING at the annual meeting of the British Electrical and Allied Manufacturers' Association, on Thursday, March 21st, the Chairman of the Council, Mr. M. J. Railing, said that the number of persons engaged in electrical manufacture was higher than at any previous time in the history of the industry. Production of electrical machinery and apparatus was rapidly rising and the maintenance of the domestic demand for electrical products, together with the industrial revival, which was fairly general throughout the country, ensured that this demand was likely to increase. The international situation gave ground for anxiety and the tariff and other barriers which had been set up in the export markets made trading very difficult. But, on the whole, the recovery of British electrical exports was a testimony to the quality and value of the products. As long as the manufacturers were given reasonable guarantee of the home market, such as the electrical industries of other nations enjoyed, they need never fear a repetition of the depression intensity of 1931. Progress had been made in the establishment of a fair trading policy, and it was hoped that before long it would be in successful operation. Close co-operation of the BEAMA and the Electrical Development Association had been maintained through the Co-operation Committee which had been established. In concluding, Mr. Railing announced that the following firms had been elected by ballot to fill vacancies on the Council: W. H. Allen, Sons and Co., Ltd., the British Thomson-Houston Company, Ltd., Crompton-Parkinson, Ltd., the General Electric Co., Ltd., C. A. Parsons and Co., Ltd., and A. Reyrolle and Co., Ltd. Later it was announced that Mr. J. A. Hirst had been elected Chairman of the Council for the coming year, Mr. E. S. New Vice-Chairman, and Mr. M. J. Railing Vice-President of the Association.

Greater London Drainage.

A REPORT issued by the Ministry of Health, on Wednesday, March 20th, recommends a fifty million pound scheme of sewage disposal for Greater London. It has been drawn up by Mr. J. R. Taylor, Engineering Inspector of the Ministry of Health; Sir George W. Humphreys, late Chief Engineer of the London County Council; and Mr. T. Pierson Frank, the present Chief Engineer of the London County Council, and deals with the co-ordination and planning of sewage disposal arrangements in an area of 25 miles radius from Charing Cross. Two schemes are examined, one for twenty-three sewage disposal works and the other for ten such works, while an alternative scheme for discharging the sewage into the sea is discussed. It is pointed out that the adoption of either of the schemes of group works would not preclude the use of a sea disposal scheme at a later date. Among other advantages of the co-ordinating scheme recommended, it is claimed that nuisance centres, or potential nuisance centres, would be greatly reduced; improvement of amenity conditions in many areas where sewage works would be abandoned and, in many cases, converted into recreation grounds or permanent open spaces; possible sources of river pollution reduced; greater and more efficient protection of sources of water supply. It is further pointed out that the larger the area that could be amalgamated within a reasonable limit the more effective and beneficial should be the result. Of the schemes examined it is suggested that the scheme for ten sewage disposal works presents the most satisfactory solution of the problem.

Colvilles, Limited.

IN the course of a speech made on Friday, March 22nd, at the fourth annual meeting of Colvilles, Ltd., held in Glasgow, Mr. John Craig, the chairman of the company, gave an interesting survey of the history of the firm. David Colville and Sons, Ltd., was, he said, until recent years, a purely family concern and owned the Dalzell Steel and Iron Works at Motherwell, which were founded by Mr. Colville, sen., in 1871. In 1914 they were the largest steel works in Britain. In 1915, at the request of the Government, the company purchased the Clydebridge Steel Company, with plate mills a few miles from Glasgow. The same year it acquired from Messrs. Merry and Cuninghame the Glengarnock Iron and Steel Works, Glengarnock, including blast-furnaces, by-product plant, and steel works. At both Clydebridge and Glengarnock during 1916–1918 entirely new steel works were erected on sites adjoining the existing plants. After the war a new plate mill was erected at Clydebridge. In 1931 Colvilles, Ltd., was formed by amalgamating the three steel works and blast-furnaces of David Colville and Sons, Ltd., with the steel works and blast-furnaces of James Dunlop and Co., Ltd. The company, therefore, represented in itself the result of a concentration and a rationalisation of the Scottish steel trade, since it is the incorporation of four separate companies which were in existence in 1914 and the plate and section trade of two other concerns. It had the capacity to produce 1,200,000 tons per annum of steel ingots, and has rolling mills in which all these ingots can be transformed into plates, sections, and bars to meet all the requirements of shipbuilders, boilermakers, tube makers, structural and railway engineers, and even the special requirements for automobiles and aeroplanes. The Clyde Ironworks were, he said, now being modernised, and electrical gas cleaning plant installed, which would allow the adjoining Clydebridge Steel Works to utilise the surplus blast-furnace gas.

Gebel Aulia Dam.

IN our Journal notes of January 22nd and November 4th, 1932, we described the principal features of the Gebel Aulia Dam, near Khartoum, the engineers for which are Messrs. Coode, Wilson, Mitchell, and Vaughan-Lee, of Westminster. From a recent report by *The Times* correspondent at Khartoum, it appears that Messrs. Gibson and Pauling, the contractors, have succeeded in completing the programme laid down for the first year before the arrival of the floods. The Gebel Aulia Dam, though not the most difficult to construct, is probably the longest in the Egyptian irrigation scheme. It is 60ft. high and 3 miles from end to end. The big lock is now almost completed. The solid masonry dam west of the lock has not been built up, as it will remain as the last portion to be constructed. Its foundations are, however, completed. East of the lock the sluice dam is in process of completion. It will be 496 yards long and will have sixty openings, ten of which will be blind. Beyond this comes a further masonry dam of 750 yards, and the final 2 miles consists of concrete encased in sheet piling. Subject to unforeseen difficulties, the whole dam should be completed well within the four years laid down in the programme, and then the reservoir will be filled, involving the flooding of some 300 miles of country for a width of 4 miles. The new barrage will supply Egypt with 2,000,000,000 tons of water.

The Late Sir George Clark.

THE death took place on Saturday afternoon, March 23rd, of Sir George Clark, one of the founders of the Belfast firm of Workman, Clark and Co., Ltd. Sir George, who died at his Belfast home, was seventy-four years of age and only recently retired from the Belfast Harbour Board and had offered himself for re-election. He was a Senator of the Northern Parliament of Ireland and was Chairman of the Great Northern Railway of Ireland from 1926 to 1934. He was also a founder member since 1890 of both the Management and the Technical Committees of the British Corporation Register of Shipping and Aircraft. Besides being a director of several Belfast firms, he was a Deputy Lieutenant of the County of Belfast. When in 1880, in association with Mr. Frank Workman, he founded the firm, the shipyard occupied about 4 acres of land and employed 150 men, and the first year's output consisted of two steamers of 800 tons. Even in those days the founders must have foreseen for their yard a much wider field of activity than could be handled by these small beginnings, because two years after its foundation the firm was building vessels 400ft. in length. In 1902 it held the world's record for output of tonnage, and in 1909 several famous ships were built there. After the war, when the company came under the control of the Northumberland Sh pbuild ng Company, Sir George opposed the change and severed connection with the firm. The company was, at a later date, reformed under the title of Workman, Clark (1928), Ltd., with Mr. William Strachan as its chairman.

The Internal Combustion Engine Group.

IN our issue of December 21st, 1934, we announced in a Journal note the formation of an Internal Combustion Engine Group among the members of the Institution of Mechanical Engineers. The Spring Meeting of the new Group took place at the home of the Institution on Monday and Tuesday, March 25th and 26th, under the chairmanship of Mr. Charles Day, Past-President. Monday afternoon was devoted to the consideration and discussion of a group of papers on "Supercharging," which was introduced by Mr. A. H. R. Fedden, of the Bristol Aeroplane Company, who summarised current aircraft practice. Mr. Sterry B. Freeman dealt with the application of supercharging to marine oil engines and the results obtained; while Mr. L. E. W. Pomeroy, of M. A. McEvoy, of Derby, described the application of superchargers to touring car engines. It was left to Mr. H. R. Ricardo to present a few points against supercharging, which he accomplished in an excellent way and drew the fire of many speakers in the discussion which followed. The meetings were continued on Tuesday morning when four papers on the gas engine as a competitor in the power field were presented and discussed. Mr. J. Jones, of the National Gas and Oil Engine Company, dealt with engines using waste gases; while Mr. E. J. Tatman, of the Crossley Premier Oil Engine Company, took as his subject the large gas engines used in mines and in steel works. Mr. W. A. Tookey gave a valuable summary of modern practice with engines using town gas; and Mr. Oswald Wans, of Ruston and Hornsby, Ltd., dealt with engines working on suction gas produced from waste products. A feature of Tuesday's papers was the comparative working costs of gas and oil engines which were given. The meetings were well attended and on each occasion a vigorous and useful discussion took place. On the social side, there was an informal tea at St. Stephen's Club, and an informal luncheon at Church House, Westminster, and a visit to the Southall Works of the Associated Equipment Company, Ltd. The meetings provided an opportunity for designers, manufacturers, research workers, and engine users to come together in a manner which augurs well for the future.

Safety at Sea.

IN the course of his reply to questions in the House of Commons on the recent loss during heavy weather at sea of the British steamers "Saxilby," "Millpool," "Usworth," "La Crescenta," and "Blairgowrie," Mr. Walter Runciman, the President of the Board of Trade, said that he had invited Lord Merrivale, the President of the Admiralty Court, to be a Wreck Commissioner and to preside over an open inquiry covering the widest possible grounds. In dealing with the Board of Trade surveying powers, Mr. Runciman admitted that the decision of what might be an efficient deck hand was a difficult and technical question. The Board of Trade had, he said, done its work well and the standards on British ships and in British ports were higher than those of other countries. From the losses recently sustained, which were a matter of deep regret, it was not to be supposed that the losses in the British mercantile marine had got out of hand or were more serious than usual. The number of lives lost since 1928 had fallen to an average of thirty-nine per annum, and that was a very remarkable result when they remembered the losses which formerly took place. It was an exaggeration to say that the marine industry was more dangerous than others, and it would be a fortunate thing for many industries in this country if their death roll was so small. In replying to the debate, Dr. Burgin, the Parliamentary Secretary to the Board of Trade, said that he could give an assurance that the Board of Trade would consider the question of exercising some control over the entry of apprentices while there were so many officers out of work.

Noise of Motor Transport.

AT a meeting of the Royal Society of Arts, on March 20th, under the presidency of Mr. Hore-Belisha, the Minister of Transport, an interesting lecture was given by Wing-Commander T. R. Cave-Browne-Cave on the subject of the nuisance caused by noisy motor vehicles. The lecturer, who is a member of the Council of the Anti-Noise League, referred to the efforts now in progress to silence the exhaust of vehicles and to the fact that matters were now entirely dependent on the Minister of Transport's actions, in co-operation with manufacturers, in setting up a standard of silence applicable to all vehicles, which should be reasonable and practical. Mr. Hore-Belisha, when introducing the lecturer, said that it was his intention as Minister of Transport to free the motor vehicle from two bars to its complete popularity: its association with danger, and its noise. With regard to the latter, the present regulations, while laying down the law that a vehicle should be efficiently silenced, and prohibiting the user from creating excessive noise, did not set up any standard as to what should be an efficient degree of silence, or what an excessive noise. A committee, under the chairmanship of Sir Henry Fowler, had been in session for several months on the subject of that standard. It should soon be possible for the manufacturer to market a vehicle efficiently silenced to a certain standardised figure. There, however, the manufacturer ceased to be of assistance. The noise produced by a vehicle depended even more on the user than on the vehicle. There was a large group of motorists who seemed to regard the noise produced as a figure giving the efficiency of the vehicle or the skill of the driver. It was to be hoped that public opinion would gradually educate that group to the fact that the reverse was the case, that noise indicated wasted power, and, more frequently, bad driving, and that a noisy vehicle on the road was neither more nor less than a public nuisance.

A House of Science for London.

THE first step towards the establishment of a House of Science in London has been taken by the three principal chemical industry organisations: the Society of Chemical Industry, Chemical Society, and Institute of Chemistry. A draft agreement for co-operation in administration of these societies has already been drawn up and appears in the current issue of *Chemistry and Industry*. During the last sixteen years there have been spasmodic efforts to bring about this co-operation, and Mr. Edwin Thompson, the President of the Society of Chemical Industry, at a recent dinner in Birmingham, urged the need for Great Britain to follow the example of France in the construction of a Chemistry House, and even went as far as to suggest the use of the site of Burlington House for the purpose. The completion of this agreement for the united administration of three important societies, representing some 14,000 scientists, marks the first definite stage of progress in the movement which has as its goal the building of scientific headquarters for scientists in London.

The Development of Parsons Industrial Turbo Machinery.

No. XII.

(*Continued from page 293, March 22nd.*)

100 KW GEARED IMPULSE TURBINES AT 10,000 R.P.M.

IN 1923, the same year in which Messrs. Parsons were constructing their first 50,000 kW unit for the Commonwealth Edison Company of Chicago, they received an order for seven turbines almost at the other end of the scale of magnitude. These were direct-current turbo-generators, each of 100 kW capacity, for the Tallah and Pulta pumping stations of the City of Calcutta. For such small machines it was decided to adopt the impulse principle of design, and to take advantage of the possibilities of gearing to enable a high blade speed to be employed in a machine of small diameter. The turbines were constructed with four pressure stages only, the first two stages having two-row velocity compounded wheels, and the other two stages having simple one-row impulse wheels. The running speed was 10,000 r.p.m., which was reduced to 3000 revolutions for the dynamos by gearing. The high turbine speed enabled a mean blade velocity of 567ft. per second to be obtained with a mean wheel diameter of only 13in. The equivalent value of the Parsons coefficient "K" was about 338. Steam was admitted to the turbines at a gauge pressure of 200 lb. per square inch, superheated to 550 deg. Fah., and exhausted into a vacuum of 27·5in.

A section through one of the machines is given in Fig. 106, while Fig. 105 shows a set in course of erection at Heaton Works. The rotor, as will be seen, was made from a single forging with the wheels carved out of the solid. The blading was of stainless iron throughout. The nozzles for the velocity compounded stages were machined internally on all sides, being made in two parts bolted to the diaphragms to enable this to be done. The first set of nozzles were confined to the lower half of the casing, so that no high-pressure joint had to be broken when the cover of the turbine was lifted. The nozzles for the two simple impulse stages were formed by casting suitable division plates in the respective diaphragms.

Several notable modifications in design were introduced in these turbines. One of these was the incorporation of the thrust block in the high-pressure

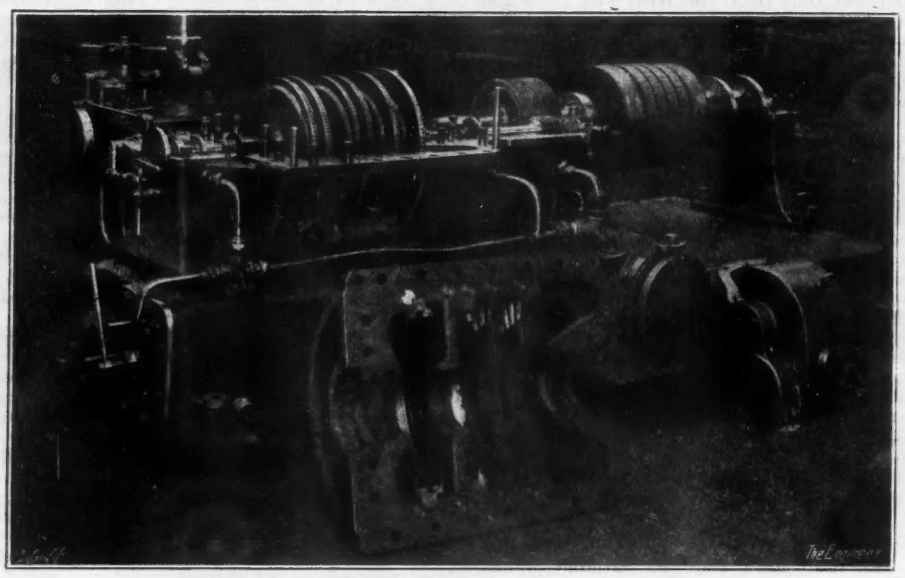

FIG. 105—100-KW TURBO-GENERATOR UNDER ERECTION—1923

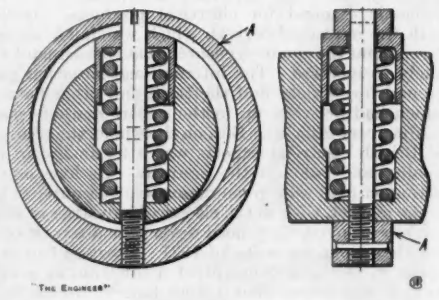

FIG. 109—RUNAWAY GOVERNOR

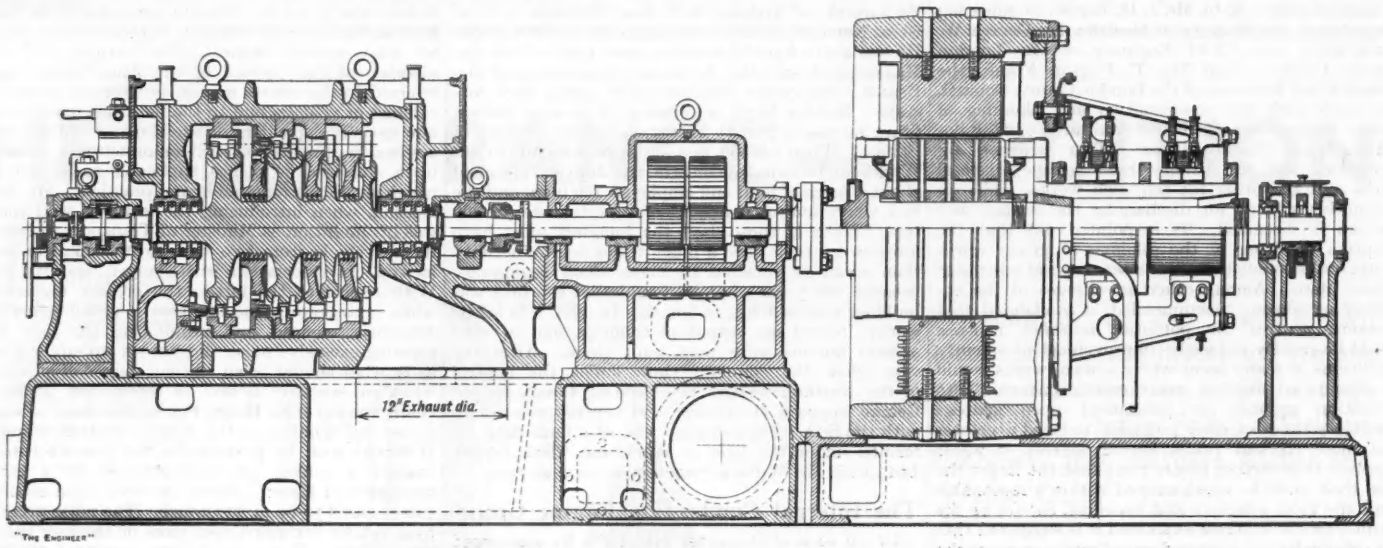

FIG. 106—SECTION THROUGH 100-KW TURBO-GENERATOR FOR CALCUTTA—1923

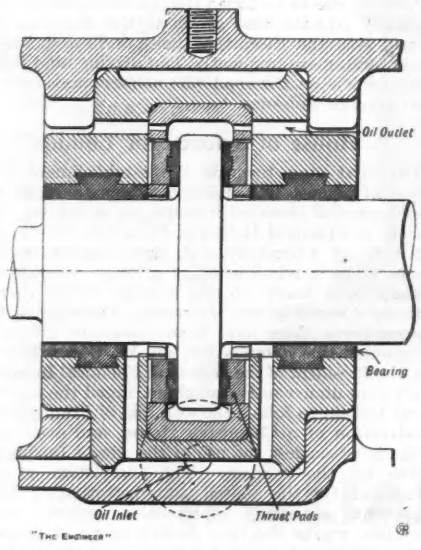

FIG. 107—H.P. BEARING AND THRUST BLOCK

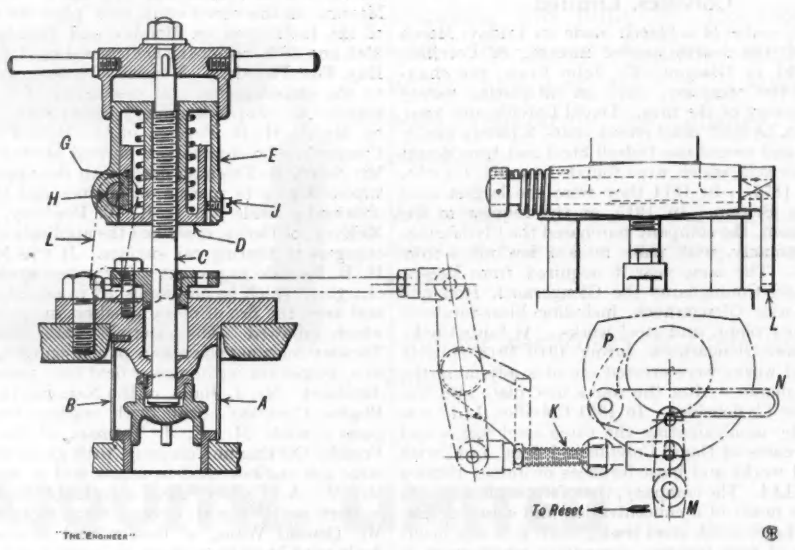

FIG. 108—RUNAWAY AND STOP VALVE

bearing. The details of this arrangement are shown separately in Fig. 107. The end thrust to be taken was very small, the thrust collar serving primarily to locate the turbine spindle axially in the cylinder. Another innovation was in the design of the runaway

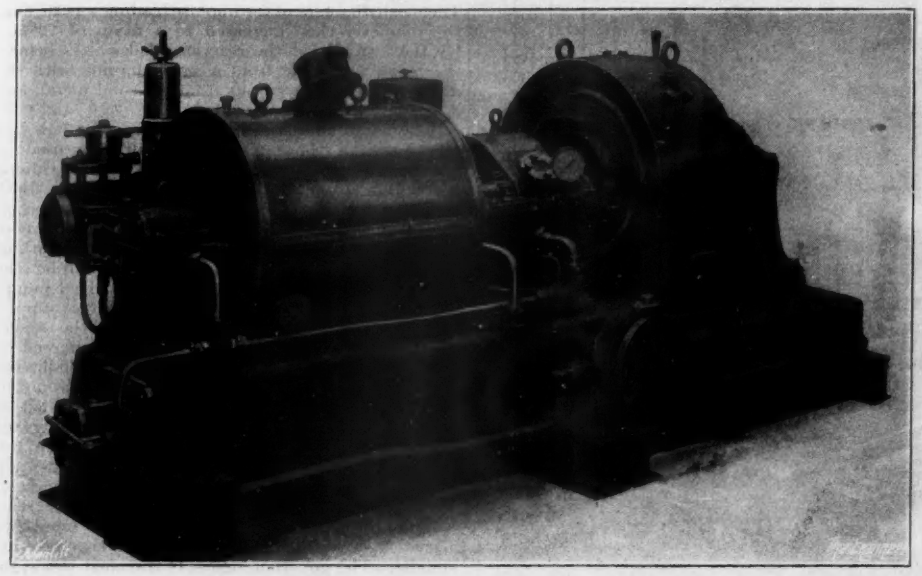

FIG. 110—COMPLETED 100-KW TURBO-GENERATOR—1923

governor. This consisted of an unbalanced ring A surrounding the turbine spindle, as shown in Fig. 109. The component parts of the arrangement were so proportioned that the centre of gravity of the complete assembly lay slightly off the centre line of the

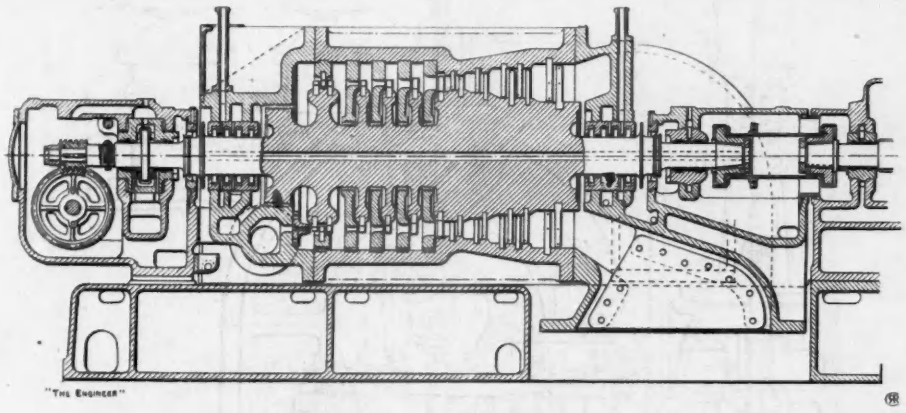

FIG. 111—817 B.H.P. "COMPOSITE" TURBINE—1925

turbine spindle, and towards the heavier side of the ring. The external surface of the latter was normally concentric with the spindle, but when the turbine attained its tripping speed of about 11,000 r.p.m. the unbalanced centrifugal force of the ring overcame the

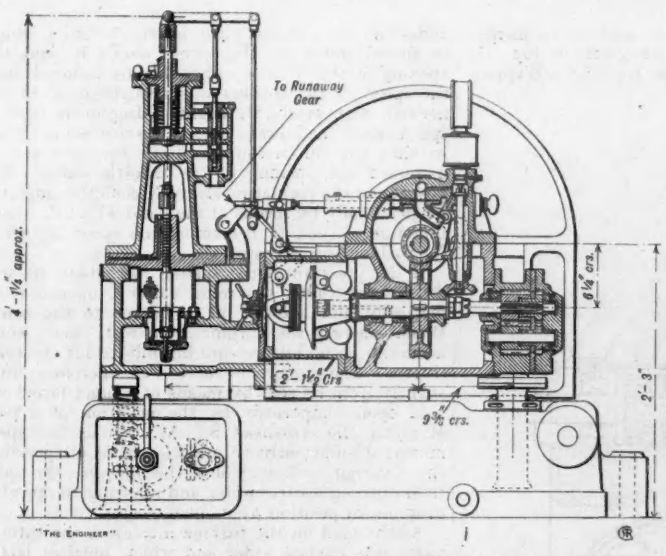

FIG. 112—CROSS SECTION THROUGH 817 B.H.P. TURBINE

pressure of the spring, with the result that the ring flew out sideways into an excentric position and operated the tripping lever, thus bringing about the instant closing of the combined runaway and stop valve.

The design of this valve is shown in Fig. 108. The incoming steam passed first through a strainer A and then downwards through the valve B. This valve was attached to the end of the spindle C, which was screwed into the spring holder D. The latter was a sliding fit in the bridge piece E, which was carried by pillars from the valve cover. A piece of hardened tool steel G let into the spring holder is provided with a notch for the reception of the trip spindle H. This spindle is held in the notch by a torsion spring and the small screw J prevents rotation of the spring holder. When the valve is open and the machine attains its tripping speed the runaway governor strikes the finger P, lifting the lever N, and allowing the spring K to release the catch of the trip spindle H by means of the lever L and the rods and levers shown. The main spring then forces down the spring holder and valve spindle and closes the valve. To re-open the latter the hand wheel is turned until the spring holder D is screwed up the spindle sufficiently far for the catch H to be re-engaged, which is done by the hand lever M when the valve can be operated by the hand wheel in the same manner as an ordinary stop valve.

The speed governor acted directly on the throttle valve, no relay being interposed. It was driven by skew gears from the main gear wheel shaft. Forced lubrication for the turbine and gear was provided by a pump on the governor spindle, but ring lubrication was relied on for the outboard bearing of the dynamo. The latter delivered 100 kW continuous current at 220 volts, and ran, as has been mentioned, at 3000 r.p.m. The magnet yoke was of cast iron and carried four laminated main poles and four steel interpoles bolted to it. The armature windings were in semi-open slots and their end turns were supported on brass rings and held by layers of binding wire. The core was ventilated both axially and radially. The commutator was strengthened by three heavy steel rings shrunk on over the bars, from which they were insulated by mica bushings. The two end rings were grooved to take balance weights. The brushes were of the spring-loaded type.

The overall length of each set was 9ft. 1·25in. The total weight was about 3·5 tons, including the bed plate in which were incorporated the oil reservoir and the oil cooler. The performance of the machines was very satisfactory, the steam consumption under the specified conditions being 19·8 lb. per kWh, which is a good figure for such small plants. The appearance of the machines was also attractive, as will be seen from the photograph of one of the sets reproduced in Fig. 110.

TURBINE WITH VELOCITY-COMPOUNDED, SIMPLE IMPULSE AND REACTION BLADING.

After the 100-kW geared turbo-dynamos had been supplied to Calcutta, a number of 250-kW units, also of the impulse design throughout, but running at 9000 r.p.m., were built for various duties in this country. When rather larger outputs were called for the advantages of the reaction principle could not be neglected, especially in the low-pressure end of the turbine, where the blade lengths were sufficient to enable the theoretically superior efficiency of reaction blading to make itself evident. The natural evolution of the Calcutta design led, therefore, to a turbine having velocity-compounded blading of the Curtis type at the high-pressure end, followed by simple impulse blading of the Rateau type for the intermediate stages, and terminating with Parsons reaction blading for the final stages.

The first example of such a thoroughly composite kind of turbine was a machine constructed by Messrs. Parsons for the Wapping Pumping Station of the London Hydraulic Power Company in 1925. The turbine was rated at 817 b.h.p. and was required to drive a centrifugal pump delivering 1000 gallons per minute against a head of 1960ft. It operated with steam at a gauge pressure of 150 lb., superheated to 466 deg. Fah., and exhausted at a vacuum of 28·6in. The normal speed of the turbine was 8000 r.p.m., and it drove the pump at 1550 r.p.m. through gearing.

A section through the turbine is reproduced in Fig. 111. The first stage consisted of a two-row Curtis wheel. Then followed four simple impulse stages of the Rateau type, and lastly five reaction stages. The whole of the blading was on a constant mean diameter of 17·5in., the mean blade speed therefore being about 611ft. per second. The rotor was made of a single forging, having the wheels carrying the impulse blading machined from the solid. It was bored axially with a hole 0·75in. diameter and 68in. long, extending from the low-pressure extremity of the shaft to beyond the gland at the other end. The boring of rotors in this way was introduced by Messrs. Parsons about the time of the construction of this machine, with the object of verifying the quality of the metal and the soundness of the interior of the forging. This practice has never since been departed from at the Heaton Works. As in the Calcutta machines, the axial thrust was taken by a combined bearing and thrust block, but the presence of the reaction blading made a dummy piston necessary in the present case. Another difference from the earlier design was the double flexible coupling between the turbine and the pinion shaft.

A cross section through the steam end of the turbine, taken on more than one plane in order to show the arrangement of the parts more clearly, is reproduced

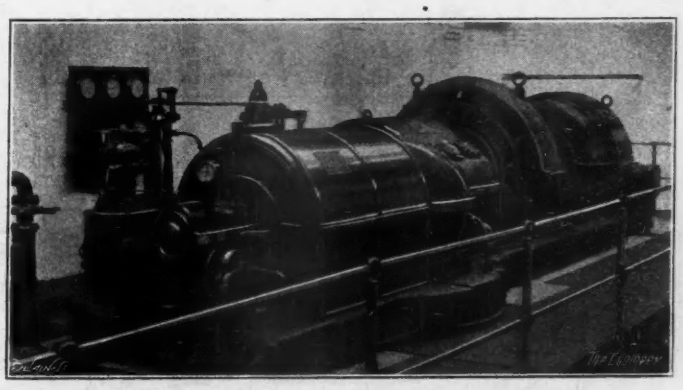

FIG. 113—1250-KW TURBINE AND GENERATORS AT HIGH WYCOMBE—1925

in Fig. 112. The main governor was driven by worm gearing from the turbine spindle, and operated the plunger of an oil relay by means of a lever train. The motion of this plunger allowed the admission of oil

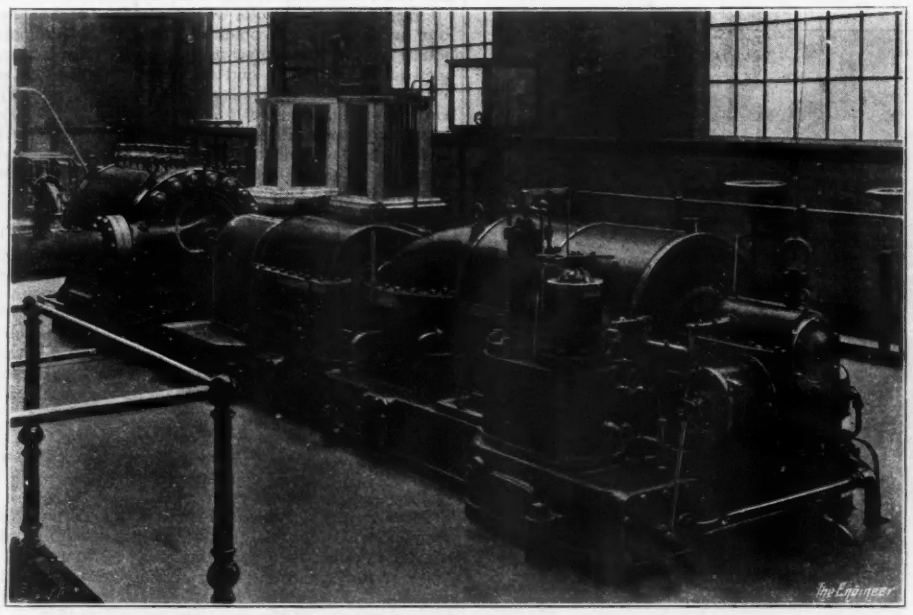

FIG. 114—817 B.H.P. TURBINE AND CENTRIFUGAL PUMP AT WAPPING—1925

to, or its escape from, beneath the spring-loaded relay piston, which was mechanically connected with the throttle valve directly beneath it by means of a cross-head and side rods. If the speed of the turbine tended to fall, in consequence of an increase in the load, the relay plunger was lowered, permitting more oil to enter the relay cylinder and thus bringing about the increased opening of the throttle valve. Conse-versely, if less steam were required to maintain the turbine speed, the plunger was lifted by the governor and some oil was permitted to escape from beneath the relay piston, which then descended and caused the partial closing of the throttle. The linkage of this piston to the relay plunger, however, resulted in the relay plunger always being restored to its neutral position as soon as any required adjustment had been effected, thus preventing further motion of the throttle valve. The main stop valve was of the com-bined stop and runaway type, similar to that illus-trated in Fig. 108 in connection with the Calcutta machines.

The appearance of the pumping unit on site is illus-trated in Fig. 114. Its performance was so satis-factory that in the following year similar units were ordered for the pumping stations at Rotherhithe and Grosvenor-road.

COMPOSITE TURBINE WITH OIL-OPERATED GOVERNOR GEAR.

The development of the composite type of turbine was carried a step further in 1925 by the construction of a geared turbo-generator of 1250-kW capacity for the supply of both continuous and alternating current. The turbine ran at 6500 r.p.m., this speed being geared down to 750 revolutions for driving a 1000-kW dynamo generating continuous current at 460 volts, and a 500-kW alternator generating three-phase current at 6600 volts. It worked with steam at a gauge pressure of 155 lb., superheated to 600 deg. Fah., and exhausted into a condenser at a vacuum of 28·8in. The set, a photograph of which is reproduced in Fig. 113, was put into service at High Wycombe. It was interesting from many points of view, especially as being the first turbine to be built at the Heaton Works with

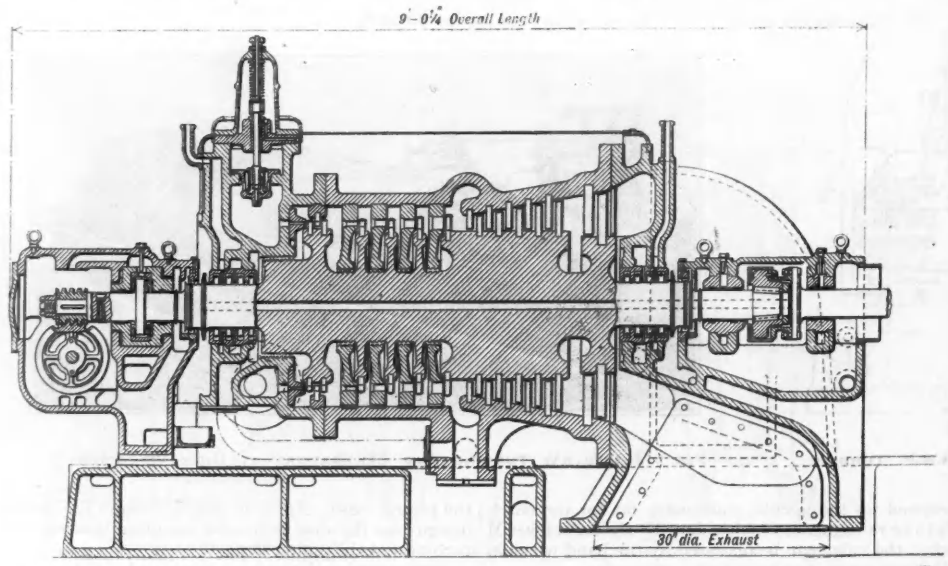

FIG. 115—SECTION THROUGH 1250-KW TURBINE FOR HIGH WYCOMBE—1925

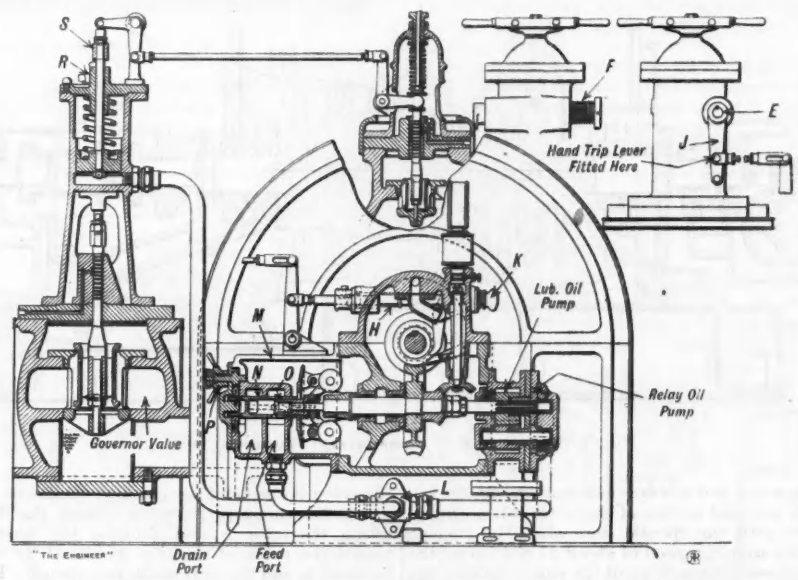

FIG. 116—CROSS SECTION THROUGH STEAM END OF 1250-KW TURBINE

turbine previously described, had one stage of velocity-compounded blading, four stages of simple impulse blading, and five stages of reaction blading. The design was, however, improved by eliminating all steps in diameter from the low-pressure end of the rotor, so as to provide the most favourable con-ditions possible for an undisturbed flow of the steam. The mean diameter of the impulse blading was 20·5in., the diameter then increased to a mean of 22·5in. for the last row of the reaction blades. As before, the rotor was made from a single forging with the impulse wheels carved out from the solid metal, and it was bored with a central hole.

Steam was admitted to the cylinder through two sets of nozzles, those in the lower half being used for normal loads, and those in the upper half coming into action automatically at times of overload. Both sets were under the control of the speed governor, the action of which will be understood by reference to the cross section of the steam end of the turbine given in Fig. 116. From this drawing it will be seen that there were two independent gear-wheel pumps on the end of the governor spindle, the larger supply-ing oil to the main lubricating system, and the smaller one serving the relay system. Oil was delivered by the latter pump at a pressure of about 60 lb. per square inch through the relief valve L to the under-side of the relay piston. Its pressure tended to raise the piston against the action of a spring and thus to open the main throttle valve, which was connected to the piston by a pair of crossheads and side rods. Another pipe from the relief valve led oil at the same pressure as that in the relay cylinder, to a chamber surrounding the regulating sleeve N concentric with the end of the governor spindle. The governor sleeve O travelled inside the regulating sleeve, and controlled the opening of a port through which the oil could enter the regulating sleeve and so pass away to the sump. It will be evident from the drawing that an increase in the turbine speed would bring about an increased opening of the port by the action of the governor. This would allow more oil to leak away, thus lowering the pressure under the relay piston. The latter, therefore, would be forced down by the spring above it, and the opening of the throttle valve thereby reduced until the speed of the turbine was brought back to the normal. Conversely, the slightest drop in the turbine speed closed the leakage port in the regulating sleeve, so that the oil pressure rose in the system and increased the opening of the throttle valve. The position of the regulating sleeve N could be adjusted longitudinally by means of the hand wheel P, which, therefore, served to determine the speed at which the turbine normally ran.

If the pressure in the system rose above its pre-determined value, the relief valve L opened auto-matically and allowed oil to escape to the sump. When starting the turbine from rest, there would naturally be no oil pressure initially to lift the relay piston. The governor valve was therefore lifted slightly from its seat by means of a hand lever, and held open temporarily by the insertion of a pawl R under the crosshead S. As soon as the speed increased sufficiently to create a little oil pressure, the governor took control of the machine, the valve then opening a little wider and allowing the pawl to drop out of position by its own weight.

As the load on the turbine increased, the throttle valve was opened wider and wider, until at last it was unable to admit any more steam to the lower set of nozzles. As this point was approached the upper end of the relay piston-rod came into contact with the arm of a bell-crank lever connected by linkwork with a valve controlling the admission of steam to the upper set of nozzles. Any further motion of the relay piston, therefore, brought about the opening of this overload valve. This valve was

governor gear operating on the "leak-off" principle.

From the longitudinal section given in Fig. 115 it will be seen that the rotor, like that of the Wapping

always under the control of the governor, and it closed again automatically as soon as the load conditions once more became normal.

The combined runaway and stop valve with which the turbine was fitted was of the same design as that already illustrated in Fig. 108 above. In the event of overspeeding the operation of the runaway governor tripped a catch and allowed the lever J—Fig. 116—to be pulled to the right by a spring provided for this purpose, thus turning the spinde E and releasing the valve. The latter was then instantly closed by its operating spring. The trip levers could be reset without reopening the valve, by merely pushing a knob. The valve could also be tripped by hand at any time without disturbing the setting of the lever gear.

(To be continued.)

Institute of Metals.

No. III.

(Concluded from page 307, March 22nd.)

ON Thursday morning a paper by W. E. Alkins and A. P. C. Hallowes on "The Reduction by Hydrogen of Stannic Oxide Contained in H.C. Copper," summarised below, was presented for discussion.

HYDROGEN AND STANNIC OXIDE IN COPPER.

Samples of H.-C. copper wire, No. 16 s.w.g., containing 0·021 per cent. of stannic oxide, SnO_2, were heated in a constant current of hydrogen for periods of 15, 30, 60, and 120 minutes at temperatures, increasing from 550 deg. to 850 deg. Cent., and the tin-oxide content determined after each treatment. The results show that reduction of the stannic oxide commences at about 550 deg. Cent., and that it is complete after 30 minutes at 850 deg. Cent., and after 60 minutes at 800 deg. Cent. Thus, in the case of coppers containing amounts of tin oxide such as are usually encountered, conditions of temperature and time which are satisfactory for determination of "loss in hydrogen" will effect complete reduction of any stannic oxide which may be present.

DISCUSSION.

Professor D. Hanson said that stannic oxide occurred commonly in commercial bronzes, and could be detected in the form of well-marked crystals having a very characteristic appearance under the microscope, because the inclusions were either translucent or transparent, and appeared beautifully coloured. The paper pointed to the easy reduction of the oxide, and that had a bearing on the general question of unsoundness in copper alloys containing tin oxide. It would have been interesting if the authors had studied the effect of hydrogen on the liquid metal, particularly with reference to the formation of gas during cooling. There were certain forms of unsoundness in bronzes which gave rise to a finely distributed porosity in the finished castings, very similar to the steam unsoundness in copper, which he believed was due to the inter-reaction of oxygen and hydrogen while the metal solidified. The equilibrium conditions of that reaction probably differed quite markedly from those in pure copper, because in bronzes the oxygen occurred, in the solid state, mainly as SnO_2 and not as Cu_2O. He had made up alloys of stannic oxide and copper by adding the pure oxide to copper. The oxide dissolved quite readily, and on solidification characteristic primary crystals separated out from the liquid, the ground mass containing what looked like a eutectic of fine particles of stannic oxide and copper, so that the reactions were very similar to those between cuprous oxide and copper. The work on stannic oxide was necessary to an understanding of the behaviour of some of the bronzes. He asked whether the authors had noticed in their samples, after heating in hydrogen, the kind of brittleness that occurred when oxidised copper was reduced in hydrogen; he had no doubt that it did occur.

Mr. S. L. Archbutt recalled a paper by his father some years ago, which showed that it was not necessary to melt the copper to get all the oxygen out of it by reduction in hydrogen; the process worked quite satisfactorily in the solid state. The authors' work had further substantiated the reliability of the old-established method of determining oxygen in copper by reduction in hydrogen. With regard to a statement in the paper that the tin oxide was uniformly distributed, he asked if that meant that it was not present as a eutectic.

Dr. H. W. Brownsdon, emphasising the great importance of arriving at clear ideas of the composition of the material, said the work dealing with tin in both the metallic and oxidised condition was a matter of interest which applied to many of the other impurities in copper. With regard to a statement in the paper that it was doubtful whether tin present in the form of oxide was detected by spectrographic methods, he said one would anticipate that it would reveal itself spectrographically just as well as if it were present as a metal. He criticised the use of the term "loss in hydrogen" as being too indefinite for use in metallurgical circles, and said it needed qualifying. Undoubtedly some of the loss was water, and CO_2 started coming off at a very early stage of the heating in considerable quantities.

Mr. G. L. Bailey, who presented the paper on behalf of the authors, said they would reply in writing. The main interest of the paper to him, as to others, was not so much what was stated in it, but rather the lines for further work which it suggested. Further work on the equilibrium relations between stannic oxide and copper, and bronze, would be of great advantage to people handling these materials. The amount of stannic oxide with which the authors dealt in the paper, and the material they handled, were very limited. They used a tough-pitch copper containing 0·06 of oxygen; it would have been brittle after the hydrogen treatment, on account of the amount of oxygen present. It was very definitely embrittled, but he would like to know, with Professor Hanson, whether in a more or less deoxidised copper containing only stannic oxide and no copper oxide—if such a material could be obtained—the same embrittling effects occurred. Presumably they did. He hoped the authors would investigate not only deoxidised coppers which might contain stannic oxide, but tin bronzes and other materials, and would also study the equilibrium relations.

The President described the work covered by the paper as an interesting example of the increased attention being given to the composition and properties of relatively pure metals, containing small amounts of oxygen, hydrogen, carbon, and other impurities; the complexity of these systems was beginning to be realised. The most complex case known in ordinary practice was probably that of steel. Some of the purer steels had at least half a dozen different elements present in very minute amounts, and their presence was responsible for a good many peculiarities. But the importance of small contents of impurities (including those which were gases at ordinary temperatures) and of their state of chemical combination, was being increasingly recognised in non-ferrous metals.

ALUMINIUM SAND CASTINGS.

Professor Hanson and Dr. Slater then presented a paper entitled "Unsoundness in Aluminium Sand Castings: Part III, Solidification in Sand Moulds under Pressure." In this paper the authors remark that by allowing gassy aluminium alloy melts to solidify in sand moulds under an extraneous pressure of air or nitrogen, pinholes are reduced in size and ingots of high density may be obtained. With most aluminium alloys a pressure of 50 lb. per square inch is sufficient to remove all visual traces of pinholes from a 2in. by 2in. diameter sand-cast block. At higher pressures ingots having densities approaching the optimum are obtained. The applied pressure appears to affect the gas cavities by compressing them to finer dimensions. The mechanical properties of the alloys are much improved by solidification under pressure, whilst shrinkage is confined to a single cavity.

The paper includes a section headed "Discussion," which discusses the results and the practical considerations arising from them. It was included by the authors in order to provoke discussion and they were amply justified in the result.

Dr. C. H. Desch said he thought that the authors had used a rather complicated method of producing castings, because the small specimens showed really enormous shrinkage cavities which would give rise to very serious difficulties. Something more elaborate than an autoclave would have to be used. It would be very much better to make good metal first and cast that, getting rid of the gas, instead of using the second-best method of covering up the defects by compressing the gas into a small space. Probably the authors agreed with that. As to the behaviour of the gas, the solubility of hydrogen in molten aluminium was fairly well known, and the solubility in solid aluminium seemed negligible. Hence the authors' explanation that the effect of the pressure was to make the pinholes very small and to compress the gas within those pinholes was probably right. It was not a question of affecting the solubility, but merely a mechanical closing up of the cavities.

Mr. R. B. Deeley, whilst appreciating the value of the paper, was disappointed that the authors did not pursue to a conclusion some of the avenues of investigation suggested by their results. In particular, it appeared that by a slight extension of the work the relative importance of intercrystalline shrinkage and of gas content could have been clarified. Generally, gas manifested its presence in alloys such as L 5, L 11, and Y alloy, which had a long freezing range, by holes which were almost spherical, while in alloys of nearly eutectic composition the holes were angular. Mr. Deeley gave a somewhat detailed explanation of this difference, and said it would be realised that the relative importance of gas content and shrinkage must be widely different in the two types of alloy under consideration. The long freezing range alloy would have a large number of small pockets containing low freezing constituent and many of these pockets would be below limiting no-void size; while the near eutectic alloy would have, owing to the smaller number of comparatively large colonies, a small number of large pockets, many of which would be above the limiting size. In other words, for the same gas content the near-eutectic alloy would have a larger percentage pore space than the long freezing range alloy, provided the contraction on freezing of the last freezing constituent was the same for both alloys. It might be assumed, then, that the effect of gradual increase of the pressure applied during solidification would progressively decrease the percentage pore space until a pressure was reached at which no internal shrinkage cavities could form, and up to that point the decrease in pore space would be due partly to the compression of the liberated gas and partly to the decrease in size of the shrinkage cavities. Subsequent increase of the pressure should merely compress the gas according to Boyle's Law. Some of the authors' remarks would tend to suggest that that was the case; but, plotting density results against applied pressure gave a curve from which it must be concluded that intercrystalline shrinkage was, within the experimental limits, never completely prevented by applying pressure.

He suggested that the authors might consider the possibility of determining the relative proportions of the pore space due to gas and due to shrinkage. Fluxes might considerably alter the behaviour of the alloy during solidification, and consequently the proneness to internal shrinkage. The comparison of the densities of ingots cast from metal treated by various fluxes should provide an excellent practical demonstration of the value of the fluxes in promoting soundness, but a study of the effect of the various fluxes on the shrinkage in contrast with the gas content would lead to a greater fundamental knowledge of hole formation and prevention.

He hoped the method finally adopted by the authors to remove unsoundness from aluminium castings would be capable of simpler practical application than that envisaged in the last part of their paper.

Dr. A. G. C. Gwyer, referring to the effect of heat upon castings in which the holes had been closed up, and the authors' photographs showing terrific blisters which had occurred on prolonged annealing, said that that rather suggested that the method could not be applied to chill castings and rolling metal, for instance. Its application even to sand castings was open to criticism, because sand castings were employed at elevated temperatures, as, for example, in pistons, cylinder heads, and so on. He was inclined to think that the rather large increase of tensile strength in the authors' sand castings as the density increased was an exceptional result, for, in his experience, a moderate amount of pinholing had very little effect on the tensile strength; it had a big effect on elongation.

Mr. H. W. G. Hignett said the authors seemed to have proved that if one squeezed a bubble it became smaller; and they had squeezed so successfully that, if one believed all the density figures, the bubbles were smaller than no bubbles at all! With regard to some of the density figures, one must take into consideration possible variations of chemical composition, and possibly also incomplete observation of the degassing treatment. The most important aspect of the paper was not the application of the authors' method to practice, but the light which it shed on the formation of shrinkage cavities. Whether one used a pressure casting method or a degassing method on a eutectic alloy such as the silicon-aluminium alloy, the avoidance of the large independent shrinkage cavities was not merely, as stated in the summary of the paper, a matter of simple foundry technique. In the first place, foundry technique never had been simple—and if metallurgists had anything to do with it, it never would be simple. In all alloys it was difficult to produce similar properties in both the thick and thin sections of a casting, and where there were large bosses, which could not easily be fed, it was almost essential when using the eutectic alloys to avoid the removal of all the gas. In some other alloys, such as some of the bronzes, he suspected that the interchange in volume between shrinkage cavity and gas cavity occurred, even though the shrinkage cavity was not of the same form, and where it was of inter-dendritic form. When a casting had to withstand hydraulic pressure it was not so much the amount of porosity present which mattered as the form of porosity and the inter-dendritic form was usually the most dangerous. It was often advisable therefore to ensure that some gas was left in. For excellent reasons, he could not give verbatim the opinion of a foundryman to whom he had shown the paper; but in essence it was that the authors of the paper, rather than the foundrymen, should be confined to subterranean regions!

Dr. C. J. Smithells joined in the discussion by reason of the "string of misleading statements" contained in the section headed "Discussion," and said he was quite certain the authors did not believe what they had stated. He referred to some work by himself and a colleague in which they had measured the rate of diffusion of hydrogen through aluminium—

by a method described in a publication to be issued by the Royal Society. They had found that hydrogen definitely diffused through aluminium at temperatures between 400 deg. and 600 deg. Cent. at a rate about the same as that of diffusion through copper. The rate of diffusion followed $\sqrt{\text{pressure}}$, and it had a normal temperature coefficient. Hence hydrogen was soluble in solid aluminium, as it was in the molten metal, and he believed the effect of pressure was to force more gas into solution. That would also account for the point raised by Dr. Gwyer that the mechanical properties of the material, even with a lot of gas in it, were not destroyed.

Dr. R. Seligman, referring to the diffusion of hydrogen through aluminium at temperatures above 400 deg. Cent., asked if that temperature were critical.

Dr. Smithells replied that it was not. He had had to measure at temperatures at which diffusion was fairly rapid, and had worked from 650 deg. down to 400 deg. At 400 deg. diffusion was rather slow for measuring, but the rate should go down with the temperature line to absolute zero.

Dr. Seligman, commenting on the authors' reference to the increased hardness occurring on closing the pores, asked if that could be explained on purely mechanical grounds or whether Dr. Smithells' remarks did not suggest an alternative and more probable explanation.

Mr. J. H. Watson pointed out that when an alloy with a pinhole structure was rolled down and annealed, the surface showed considerable blistering, and he asked whether such an alloy if pressure cast and rolled and annealed at ordinary temperatures would not also display considerable blistering. The authors' method seemed excellent for castings which had not to be worked and heat treated.

Mr. J. D. Grogan said the net effect of solidification under pressure appeared to be to squeeze the pinholes to smaller dimensions; but he felt that the authors' conclusion was not justified by their results. There was a lot of evidence that on occasions the gases dissolved in aluminium probably never formed bubbles because they had not been given a lead to form bubbles, and therefore probably remained in atomic form throughout the mass of the aluminium. Similarly, in the authors' specimens it seemed that, as the pressure was increased, the atomic hydrogen throughout the molten aluminium remained atomic. Generally speaking, it did not form bubbles until the start of solidification; but he suspected that in that case the state of hopeless supersaturation persisted, even during solidification.

Mr. S. L. Archbutt found it difficult to understand the authors' statement that a pressure of 50 lb. per square inch was sufficient to remove all visible traces of pinholes, since the density values were so much inferior to N.P.L. results on 1in. diameter bars, containing 1 per cent. less copper, cast from degassed melts. The pressure of 50 lb. per square inch seemed too low. He mentioned some results obtained at the N.P.L. on some aluminium alloy ingots cast from degassed melts, from which it appeared that solidification under pressure of 50 lb. per square inch gave no better density than at atmospheric pressure, using a degassing process. After suggesting that further evidence was required than was contained in the paper before we could decide definitely the state of the gas retained in solid metal under the conditions described, Mr. Archbutt expressed astonishment at the authors' suggestion that solidification under pressure might be used to produce serviceable castings from melts of indifferent quality as regards gas content, since their results indicated that the gas was retained in the casting not only to a greater extent than under normal casting conditions, but, even more serious, assuming it were true, retained not in solution but as a separate phase in compressed bubbles. In such a state they must form discontinuities in the structure, which might be potential sources of failure under sufficiently searching service conditions. The authors had even suggested that ingots for rolling might be produced in this way. But Mr Archbutt imagined that sheet rolled from ingots produced from gassy metal so as to retain the gas might well be expected to give trouble on heat treatment through blistering due to expansion of the gas bubbles.

In conclusion, he acknowledged the brilliant work of Professor Hanson and his collaborators regarding gases in metals, which had culminated recently in a process for removing gases from aluminium alloys which seemed more practical and convenient to industry than some existing methods. But Professor Hanson's long association with gases must have resulted in their casting a spell over him, when he advocated turning foundries into infernal regions with atmospheric pressures of 50 lb. per square inch in order to *retain* gases in a free state in castings and ingots. Such practice was strongly to be deprecated. By all means apply pressure during solidification to reduce porosity due to shrinkage, but first remove gas from the metal!

Dr. Slater, replying to some of the "less diplomatic" questions, agreed that it was far better to get rid of gases than to employ the method described in the paper. He did not agree with Mr. Deeley's statement that the alloys having a long freezing range showed round pinholes and the eutectic alloys showed angular pinholes. The authors had observed that the dimensions of the pinholes were more or less a function of the amount of gas present in the alloy; if the amount were rather small, the holes were angular, whereas if there were a large amount of gas, the holes became round.

Commenting on Dr. Gwyer's opinion that a moderate amount of pinholes had very little effect on the tensile strength, he said the shape of the cavities had the important bearing. He would agree that round cavities would have less effect than cavities of angular shape, and which probably extended over a greater effective area throughout the metal.

He referred Dr. Smithells to recent work published in Germany, showing that most aluminium melts commercially produced were supersaturated to a high degree by gases.

In reply to Dr. Seligman, he said that the increased hardness of the pressure cast ingots, caused by the closing of pores, was explained on mechanical grounds. One could fairly safely draw the conclusion that pressure cast metal would blister on heating after rolling.

Touching on Mr. Archbutt's observations on the densities of various alloys, he said that the composition had its effect, and some knowledge of the composition would be necessary in order to make an exact comparison.

Professor Hanson, who was particularly pleased by the discussion which had resulted from the paragraphs headed "Discussion," said it was quite clear that some of the statements made in those paragraphs were not fully proved by the subject-matter in the paper itself; the authors had never pretended that they were proved. Equally, many of the remarks made by speakers were far from proved by evidence; and he did not see why they should be compelled to prove everything up to the hilt in a discussion. But the remarks were suggestive and would lead to further work of the greatest value. He hoped the full results of Dr. Smithells' work on the diffusion of hydrogen through aluminium would be made available, because it dealt with a very important practical point. Previous work had suggested that hydrogen was insoluble in solid aluminium, and very important conclusions had been based on that assumption. Nothing had been said about the amount of the solubility; but if the solubility were very small indeed under ordinary pressure, and it increased according to $\sqrt{\text{pressure}}$, it would not be very big even at the melting point. It might be so small as not to be measurable except by some intricate method. If some of the hydrogen were in the holes and some in the aluminium, we could only explain the matter quantitatively by knowing the proportions in each. Expressing the hope that Mr. Grogan would develop the point concerning bubble formation, he said N. P. Allen had shown that bubble formation and gas solubility in copper alloys must be distinguished from each other, and that bubbles were not automatically formed as soon as the limit of solubility was exceeded.

Alloys of Magnesium.

Mr. W. E. Prytherch read a paper entitled "Alloys of Magnesium: Part II, The Mechanical Properties of some Wrought Magnesium Alloys," in which an investigation into the mechanical and rolling properties of some magnesium alloys is described. The alloy systems studied have been selected with reference to their constitution with a view to the production of alloys of good mechanical properties amenable to heat treatment. Although no alloys have yet been made which respond satisfactorily to heat treatment in the manner characteristic of certain well-known aluminium alloys, some alloys having interesting properties have been studied.

Discussion.

Mr. A. J. Murphy was interested to note how close the work at Teddington seemed to have come to almost immediate practical exploitation. He asked if the author would add to the mechanical results the data on specific gravity, because it was on specific gravity that the whole case for magnesium alloys turned. With regard to the effect of temperature on the mechanical properties, it was stated in the paper that at 300 deg. Cent. one of the most promising alloys was weak. That would be true of most of the high-strength aluminium alloys as well, and in view of the remarkable resistance of the magnesium alloys to cold working, he asked that more light be thrown on the temperature above which the mechanical properties fell off rapidly.

Dr. C. H. Desch mentioned that the work described in the paper was part of a much larger investigation, and the best alloys had not yet been reached. The author was making particular use of such elements as would produce precipitation hardening, which offered possibilities of securing greatly improved mechanical properties. The main difficulty in dealing with alloys of that class was that of the initial stages of breaking down the cast structure; once the ingot structure had been broken down, mechanical working proceeded very much more easily. The rolling difficulties at first were often very great; here the time effect came in. There was considerably greater prospect of getting high-strength alloys in a ductile condition, although the original ingot structure might appear to be unfavourable. A good deal of X-ray work would have to be done in order to explain fully the remarkable changes in properties experienced with magnesium and zinc or cadmium.

Mr. H. Sutton pointed to the breaking down of the ingots as a very important part of the technology of wrought magnesium alloys, and questioned whether the author had done full justice in the paper to that part of the work, for there was nothing to indicate whether it was a quick or a slow, or an easy or difficult, process. His experience suggested that extrusion was a very convenient method of breaking down, starting from the cast metal, when it could be reasonably employed. For forging in dies, one could adopt a very much simpler and easier procedure when working from extruded material as a starting point. Discussing the production of scale during heat treatment of magnesium, he said that recently he had observed some rather peculiar thick scales on cast magnesium alloys containing up to 10 per cent. of aluminium, when heat treated in air, and he asked if the author had found any simple means of avoiding such scale formation. Finally, he commented on the very rapid improvement effected in the properties of wrought magnesium alloys during the last few years, and said the author's work would help still further in that direction.

Mr. J. D. Grogan said that in the course of the work on magnesium alloys at the National Physical Laboratory the trouble had been experienced that if the ultimate stress was increased, the ductility became very low, and if the ductility was increased, the limit of proportionality was absurdly low. The author had used a very unusual method of attack. He had added other elements to magnesium to increase its ductility. Generally speaking, one raised the strength and decreased the ductility by alloying one element with the other; but apparently he had not increased the strength at all by adding zinc or cadmium to magnesium, and he had given the metal reasonable ductility. Having thus changed the nature of the magnesium, he had added hardening elements, and in that way had effected a really remarkable advance in the metallurgy and technology of magnesium alloys.

Mr. Prytherch, replying, said that cadmium definitely increased the specific gravity of magnesium rather alarmingly; the increase of specific gravity as a result of adding 8 per cent. of cadmium was about 10 per cent. Magnesium alloys were notoriously weak at high temperature; the properties fell off even at 50 deg. or 100 deg. Cent., and at 300 deg. Cent. the strength of magnesium was only about 1 ton per square inch. The zinc-cadmium alloys were particularly weak as the result of the rather low temperature of the eutectic, which was only about 340 deg., and rolling operations had to be carried out at 300 deg.

With regard to resistance to cold-working effects, he said there was a very pronounced change in the working properties of magnesium at 220 deg.; below that temperature, working operations were very difficult to perform, and above it they became increasingly easier.

Forging as a breaking-down method had not been introduced in connection with the alloys described in the paper, and had been employed only since the paper was written. Extrusion was a quite satisfactory method of breaking down magnesium alloys, both prior to forging or prior to rolling, and extruded bar was very much more satisfactory than cast bar for forging.

A great difficulty in the heat treatment of magnesium alloys arose from the ease of scaling, forming oxide skins. These oxide skins might be sufficiently insulating to cause the metal to catch fire during heat treatment. But their formation could be avoided in three ways—by carrying out the heat treatment in a reducing atmosphere, or by coating the metal with magnesium fluoride by anodic methods, or by adding a small amount of calcium. Less than 0·1 per cent. of calcium would completely prevent any scaling; when that amount was present there was no perceptible scaling even at 500 deg.

A paper by Mr. D. M. Smith on "The Spectrographic Analysis of Aluminium" was then presented.

Ordinary photographic records of arc and spark spectra of graded series of standard alloys of aluminium with copper, iron, manganese, silicon, and titanium, have been investigated from the point of view of the establishment of a satisfactory routine method of analysis. The spark gives a steadier and more reproducible source of light, and, since adequate sensitivity of detection of the impurities usually occurring in aluminium is obtained, analytical tables have been compiled for use with the spark method. For routine testing of samples an auxiliary alloy of aluminium with 1 per cent. nickel is used for the auxiliary spectrum method, but further accuracy of determination would be obtained by direct comparison with suitably selected standard samples. The arc method is more sensitive for the detection of traces of such impurities as lead and gallium.

Discussion.

Dr. A. G. C. Gwyer asked for an explanation of the slowness with which spectrographic methods of analysis were being adopted in this country. From time to time he had submitted samples for spectrographic examination, notably when looking for elements of a rare type, and in many cases there was remarkably good quantitative agreement between the results of the spectrographic and the chemical analysis. But he could not see that a producer of metals would be justified in purchasing expensive spectrographic equipment until such time as bodies, such as the Air Ministry, for example, would accept spectrographic in place of chemical analyses.

But supposing spectrographic analysis had become accepted in place of chemical analysis, how many

analyses could be done per unit of apparatus per day? One could get through an ordinary analysis of aluminium, for example, by spectrographical methods in a short time as compared with the time taken for one chemical analysis; but, of course, in any well-organised routine laboratory perhaps 50 or 100 analyses would go through at once, so that a large number of results was obtained in a day. He imagined the instrument would cost £200 or £300. Again, if one merely wanted approximate information, as, for instance, whether the silicon content of an iron was less than 0·50 per cent. and the other impurities were less than 0·1, how long would it take to secure such information? Finally, Dr. Gwyer asked what were the possibilities of extending the method to the estimation, say, in aluminium, of rather larger quantities of the common elements—for example, copper, manganese, zinc, nickel, and magnesium?

Dr. H. W. Brownsdon, bearing in mind that the paper might be the last presented to the Institute on that subject, took the opportunity to express gratitude to Mr. Smith for all the help he had given. He added that the spectrograph could outrun the analyst, and could present the whole picture in a few minutes. He had an apparatus running daily on routine work in his laboratory.

Dr. R. Seligman, explaining why Mr. Smith's paper might be the last presented to the Institute on the subject, said the Institute had broken its rules up to the present by accepting papers on it from Mr. Smith and others because it was felt that it was not being dealt with adequately elsewhere. But he was glad that now the societies whose sphere it was to deal with analytical matters had at last become aware that there was such a thing as the spectrograph, and in those circumstances the Institute felt that it could with propriety fade out.

Mr. E. Van Someren, who had recently compared fourteen kinds of plate for spectrum photography in the ultra-violet, recommended a special lantern plate. The exposure required to record a faint line in the ultra-violet on that plate, he said, varied (with increasing wavelength) from one-hundredth to one-fifth of the exposure required on an auto-filter plate. Another advantage of lantern plates was that they had an extremely fine grain, and so enabled the operator to take advantage of the full resolving power of the spectrograph in a way impossible to users of coarse-grained plates such as anti-screen.

Mr. M. Milbourn, indicating how much could be done with one spectrograph, said he had to deal with a range of alloys, mostly copper-rich alloys, and the number of samples passing was approximately 1000 per month, or 40 per day. They included also much more complicated samples, such as ashes, where one was looking for between forty and fifty rare elements. One junior exposed the spectra and he (Mr. Milbourn) examined them. Finally, he said he preferred the internal standard method to the auxiliary standard.

Mr. Smith, replying, suggested that if there were more than two people working with one spectrograph they might be stepping on each other's feet. In an hour one could get at least thirty spectra on one plate as a matter of routine, so that two people could turn out an enormous number of photographs per day; whilst one was drying and fixing, the other could be analysing. In reply to Mr. Van Someren he said he had used half-tone thin film plates, which were very satisfactory; they required less time than the others for fixing, washing, and drying.

The President said that some years ago the British Non-Ferrous Metals Research Association had realised the possibilities of spectrographic analysis in metallurgical work; considerable spade work had been necessary in establishing the best technique and working out suitable standards for the estimation of impurities in different metals, and Mr. Smith had been engaged on the work continuously. The technique had become very well established, and Mr. Smith's recent book on the use of spectrography in metallurigcal analysis had given a great deal of information. The present paper gave information obtained since the publication of that book. Spectrographic methods of analysis were receiving perhaps more attention in America and Germany than here. Perhaps analytical chemists had shown reluctance to adopt a purely physical method, and perhaps a further reason was the relatively high initial cost of suitable apparatus. Another factor was the training required in order to use the method; but possibly the most serious difficulty was the fear that the results might not be so accurate as those of chemical analysis. That difficulty was being overcome steadily, and he believed those who had adopted the spectrograph for metallurgical analyses were making increasing use of it.

Leipzig Technical Fair.

No. IV.

(Concluded from page 299, March 22nd).

THE Leipzig Spring Fair, which included the Technical and Building Fairs, closed its successful run on Sunday, March 10th. As compared with last year's Fair, the total number of exhibitors showed an increase of over 9 per cent. The total number of firms taking part in the Fair was 8076, of which over 225 showed machine tools. Other large sections, which we do not propose to describe, included oil engines, refrigerating machinery, and electrical plant and apparatus. The total number of foreign exhibitors, of which we noted very few were British, included 180 Japanese firms and 137 Czechoslovakian firms. According to estimates, about 200,000 buyers from Germany alone attended the Fair, while the foreign buyers numbered close upon 21,000, or about 5000 more than last year. In what follows we conclude our brief review of some of the machine tools of outstanding interest which were shown at the Fair.

FIG. 26—ROTARY GUILLOTINE SHEARS—SCHULZE

SCHULZE AND NAUMANN.

With the increasing use of welding in marine work and in structural engineering, the use of a bevel cut is rapidly increasing. A new type of rotary guillotine plate shearing machine was exhibited by Schulze and Naumann, of Köthen-Anhalt. It is designed to make either right-angle or bevel cuts without interchange of knives, the change-over from one to the other being only a matter of seconds. The machine we illustrate in Fig. 26 will cut plates 5 m. long in 10 sec. to 20 sec. It is built up of steel plates bolted and riveted. The design is simple and consists of a straight stationary lower blade, along which is moved by chain the cutting head. This head carries a circular top cutter which is free to revolve. The cutting thrust is taken up by the upper and lower girders of the machine and the carriage or cutting head is guided longitudinally by a large diameter shaft placed at the back of the machine.

The cuts are made from right to left, and can be of any length. Our illustration shows the pneumatically operated holding-down clamps. By the use of special rotary cutter heads, the machine can be quickly adapted for making bevel scarfing or welding cuts. The usual bevels employed are 18 deg. for scarfing, and 30 deg. up to 40 deg. for welding cuts. The finish of the work appeared to be very good and equal to plate edge planing. Machines of this design are built in sixteen different sizes for plates from ¼in. up to 1 $\frac{7}{16}$in. thick and for plate lengths from 8ft. up to 35ft.

COLUMBO.

A new type of high-duty hydraulically-operated saw was exhibited by the Columbo Saw Works, of Dresden, and is shown in Fig. 27 herewith. The principal feature of this machine, which is built in five sizes, designed for sawing material from 150 mm. up to 400 mm. diameter, is its hydraulic control of the pressure on the saw during the working stroke and the lifting of the saw frame during the return stroke. The pressure on the saw is clearly indicated on a small gauge and can be adjusted by a simple valve. The saw frame is carried in prismatic guide ways formed on the underside of the saw arm, which is pivoted at the end of the machine. The geared saw drive has two speeds, which can be quickly altered by means of a hand lever. When the saw cut is finished, the saw is returned automatically to its upper position, and the machine stopped. The machine can be supplied for either direct electric or belt drive. As an example of the work done, we saw a 300 mm. bar of 45-ton high-tensile steel cut through in 24 min.

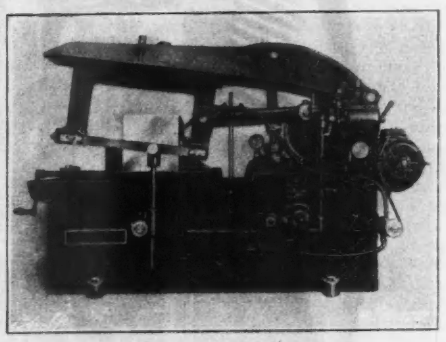

FIG. 27—HYDRAULICALLY-OPERATED SAW—COLUMBO

MULLER AND MONTAG.

The firm of Müller and Montag G.m.b.H., of Leipzig, exhibited a full range of milling and rotary copying machines. One of the milling machines exhibited is shown in Fig. 28. It has been designed for a direct vertical motor drive, which is accommodated in the upper part of the machine column. The lower part of the column carries the table slide, and houses the table feed mechanism, while the upper part of the column contains the spindle drive. The milling spindle is balanced and is fitted with a micrometer adjustment. All parts of the machine are mechanically lubricated. Our illustration shows a straight table, but, if so desired, a rotary table can be fitted. The spindle has sixteen speeds with a range from 50 to 660 r.p.m. There are eight table speeds with feeds corresponding to 0·075 mm. up to 3 mm. per revolution of the milling spindle. A rotary table of 300 mm. to 350 mm. diameter can be carried. The table shown has a length of 780 mm. and a width of

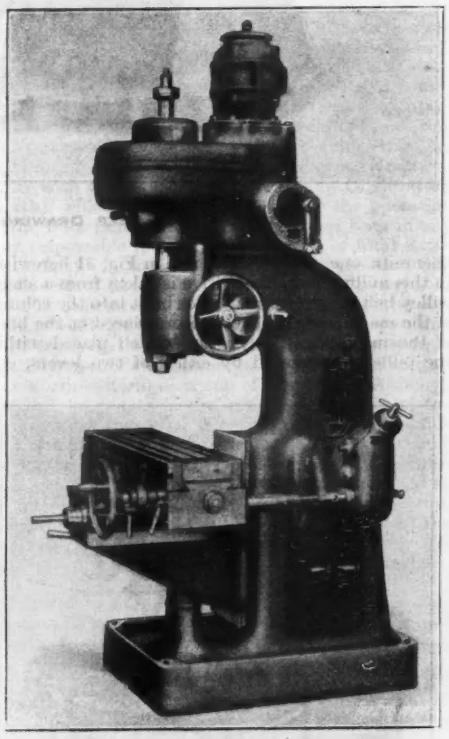

FIG. 28—VERTICAL MILLING MACHINE—MULLER

260 mm., and a vertical range of 420 mm. by hand. The machine we illustrate can be adapted for A.C., D.C. or belt driving.

BIERNATZKI AND CO.

Some new designs of vertical milling machines were also exhibited on the stand of Biernatzki and Co., of Chemnitz, one of which is shown in Fig. 31 herewith. In this milling machine a drive is taken from a single pulley belt driven from a motor built into the column of the machine or by D.C. motors placed at the back of the machine. The friction clutch placed within the pulley is operated by either of two levers, one

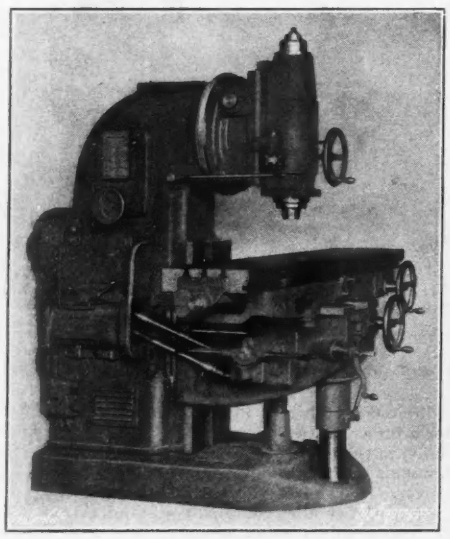

FIG. 31—VERTICAL MILLING MACHINE—BIERNATZKI

of which is mounted on either side of the column. The milling spindle, which has a diameter of 3 1/16 in. in the front bearing, has sixteen speeds and is driven through sliding gears. It is controlled by one hand wheel and two levers and is reversible. The spindle head can be swivelled, quick adjustment of the head being carried out by a star-shaped handle and the fine adjustment by a hand wheel working in connection with worm wheel and worm gearing. The machine is complete with both lubricating oil and cooling fluid pumps. The table feeds are sixteen in number, from 1/16 in. up to 29 1/4 in. per minute. The two models in this series have tables with working surfaces of 74 3/8 in. by 17 3/4 in. and 82 1/4 in. by 17 3/4 in. respectively, and with corresponding automatic longitudinal feeds of 48 1/4 in. and 56 1/4 in. On both models the automatic cross feed is 15in. and the automatic vertical feed 14 1/4 in.

L. SCHULER.

The large deep drawing press by L. Schuler, of Göppingen, formed the largest individual press exhibit in the hall. It is, as Fig. 29 shows, built up of a bedplate with two side columns and a head piece. The castings are further strengthened by through-going steel tie bolts. For this press an electric drive is adopted, with a two-to-one or three-to-one gear reduction. The gear wheels are of the single-helical toothed pattern, the angles of the teeth being opposed. The heavy construction of the plunger and its guides may be noted.

HILTMANN AND LORENZ A.G.

The illustration, Fig. 30, shows another long-stroke crank press, designed by Hiltmann and Lorenz A.G., of Aue, Saxony, for stamping, cutting, deep-drawing, or combined operations. This type of press is built in various sizes, with capacities of 100 up to 1200 tons. The double gear drive is of the straight spur type, with balanced wheels, and again the plunger guide is noteworthy for its great length and the facility provided for adjustment. By means of a special control mechanism the vertical position of the plunger can be quickly altered by electrical means. The friction clutch is so designed that it is automatically thrown out of gear just before the plunger reaches the top of its stroke. In order to avoid overstressing and probable fracture of the press, a special safety plate is built into the plunger, and is of such design that it quickly fractures under overload conditions. The electric driving motor is mounted on a bracket at the side of the press, and a V belt drive is employed. Automatic grease and oil lubrication to all working parts is provided.

Another interesting tool shown on the same makers' stand was the universal excentric type punching and riveting machine, with a swivelling table, which we show in Fig. 32. This particular machine has been specially designed for aircraft construction and motor chassis and body work, in which punching, shearing, nibbling operations, and riveting work of widely varying kinds has to be done. The machine carries besides the swivelling table a riveting horn, consisting of a circular arm which can be placed in one of two upper and lower positions. The controls are neatly arranged at the side of the machine. The tool is one which should on account of its easy adaptability and quick setting up fulfil a variety of useful purposes.

In addition to the lathe exhibits to which, in part,

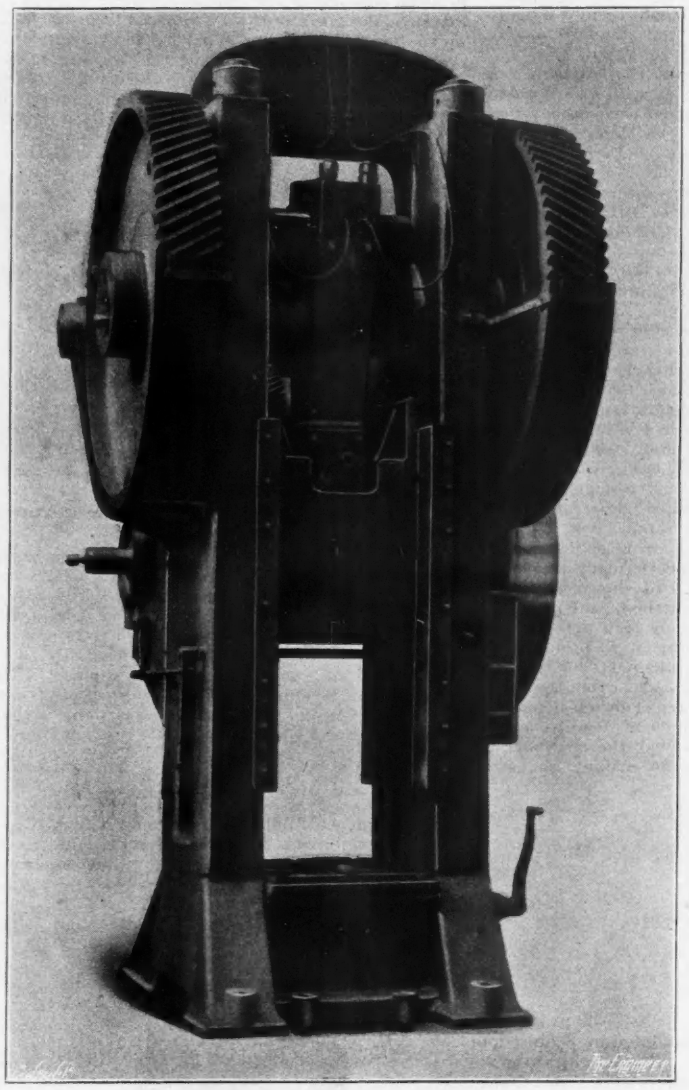

FIG. 29—LARGE DEEP DRAWING PRESS—SCHULER

FIG. 30—LARGE UNIVERSAL PRESS—HILTMANN

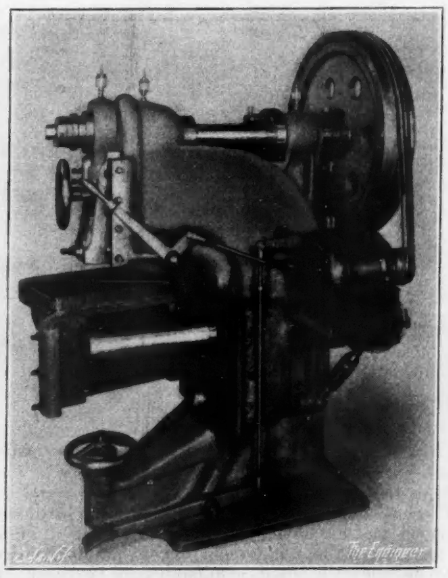

FIG. 32—UNIVERSAL PUNCHING AND RIVETING MACHINE—HILTMANN

we have already referred in earlier articles, there were, we noted, several fine examples of standardised lathes designed and built by the combined lathe firms of Gebrüder Böringer G.m.b.H., of Göppingen; Franz Braun A.G., of Zerbst; Heidenreich and

Harbeck, of Hamburg; and H. Wohlenburg, of Hanover-Brink. On the side of automatic high-speed lathes some new tools were shown by the Index-Werke and Hahn and Kolb, of Esslingen and Stuttgart; and by the Pittler Werkzeugmaschinenfabrik, of Leipzig. A special high-speed Pittler lathe was interesting by reason of the direct V belt drive, giving, with a three-pole change-speed motor, speeds of 1000, 2075, or 4200 r.p.m. or, alternatively, 710, 1430, or 2880 r.p.m. By means of a control drum driven from the turret head the appropriate spindle speeds for turning, drilling, thread cutting, reaming, and cutting off are automatically obtained. It seems likely that the new principle embodied in this special machine will be extended to other ranges of the firm's automatic lathes.

Air Pollution in 1933-34.

By JOHN B. C. KERSHAW.

ACCORDING to the Superintendent of the Air Pollution Observations, the number of stations making official observations during the year ending March 31st, 1934, was as follows:—

Measurements of deposit	96
,, suspended impurity	14
,, sulphur by vol. method	12
,, ,, lead peroxide	34

The above figures represent an increase of five deposit gauges, one automatic filter, and one apparatus for measurement of sulphur by the volumetric method, as compared with the previous year.

The official report of the observations will not be published for another week or two, and is much later than usual in its appearance, but the writer has been able to make use of the figures for solid deposits and sulphur compounds contained in the annual report of the Southport meterologist for the year 1933, and his thanks are due once more to Mr. Joseph Baxendell for an advance copy of this report.

The comparative figures for the total solids and sulphur acids collected in the gauges in thirty-one towns and cities of the United Kingdom during the year ending March 31st, 1934, are given in Table I. The results are presented in three groups, as in previous years, in order to facilitate comparison, and also to enable one to judge of the progress made in air purification during the last few years.

TABLE I.—*Comparative Figures for the Total Collection of Solid Matter and of Sulphur Acids in Thirty-one Towns and Cities of the United Kingdom During the Twelve Months Ending March 31st, 1934.*

	No. of gauges in use.	Tons per square mile per annum. Solids.	Sulphur as SO_3.
Group 1.—Under 200 Tons.			
Marple	1	94	18·4
Southport	2	104	10·8
Garston	1	109	15·2
Bournville	2	110	11·6
Huddersfield	1	111	21·5
Cardiff	1	138	13·4
Southampton	1	141	15·0
Halifax	5	153	16·8
Dewsbury	3	168	14·6
Wakefield	2	172	—
Shipley	1	192	22·1
Wallsend	1	193	18·9
Birmingham	2	198	28·4
Averages		144·8	17·2
Group 2.—200 to 300 Tons.			
Salford	2	211	21·6
Rotherham	2	217	18·7
Bradford	2	218	24·4
Edinburgh	3	220	17·6
Leeds	5	224	17·2
Rochdale	1	228	33·9
Hull	2	228	36·4
Glasgow	8	231	27·4
Sheffield	4	236	19·8
Leicester	3	237	20·8
London	11	245	29·4
Newcastle-on-Tyne	3	246	28·8
Stoke-on-Trent	2	251	—
Averages		230	24·7
Group 3.—300 Tons and Over.			
Castleford	1	301	17·2
St. Helens	1	315	32·8
Burnley	3	323	26·8
Ashington (Northumberland)	1	411	35·2
Liverpool	2	428	38·4
Averages		356	30·1

Group 1 contains thirteen towns, with deposits of solid matter under 200 tons per square mile per annum. These are seen to range from the lowest figure of 94 tons at Marple, in Cheshire, up to 198 tons at Birmingham. The average for the thirteen towns and cities which are included in this group is 144·8 tons for solid matter and 17·2 tons for the sulphur (calculated as SO_3), whereas in the previous year the averages for this group were 159 tons of solid matter and 21·7 tons of SO_3. These averages prove therefore that considerable improvement is taking place in the purity of the atmosphere of the various towns included in group 1, and that the lead which is being given by the group of manufacturing towns of the West Riding of Yorkshire is a very notable one. Birmingham is the one large city which has managed so far to obtain a place in this group, but it will probably be joined by Salford within the next year or two.

Group 2 contains also thirteen towns and cities, and includes the more important centres of industry of the country. Salford heads the list with a total deposit of 211 tons of solid matter, a result largely due to the interest in the subject of air pollution taken by the Medical Officer for Health, Dr. Osborne, while Stoke-on-Trent comes at the bottom of the list with a total of 251 tons. The average for the whole group is 230 tons of solid matter and 24·7 tons of SO_3. These figures are a considerable improvement upon the corresponding averages for the previous year, which were 246 tons and 28·3 tons respectively.

Glasgow and London, it is very satisfactory to note, can both show improved results when compared with 1832–33, Glasgow having totals of 231 tons for solid matter and 27·4 for sulphur, while London follows with 245 tons for total solids and 29·4 tons for SO_3. The London returns are submitted to a detailed examination in the second part of this article, for the Battersea super-power station has not been in operation long enough to prove whether it is having any prejudicial effect upon the London figures.

Group 3, containing the towns with deposits of 300 tons and over of solid matter, comprises five towns, all of which appeared in this same group in the preceding year. Liverpool, however, now occupies the position occupied in 1932–33 by Ashington, and has the unenviable distinction of being the dirtiest city in the country so far as these observations are concerned. The average of total solids and of SO_3 for this group, however, is rather better than in the previous year, and thus confirms the opinion which is based upon the study of the other two groups, namely, that the observations upon air pollution are leading to some real progress in smoke abatement, although this is taking place much more slowly than smoke reformers hoped when these investigations were started over twenty years ago. The important point to remember, however, is that despite the lack of any real and active legislative support, progress is being made, and in another five or ten years it would seem probable that the number of towns found in group 1 will be doubled, and that Birmingham will not be the only industrial city represented in this group of the table.

THE LONDON RESULTS.

Tables II and III contain the detailed figures of the London observations for total solids and sulphur impurities for the three years ending March 31st, 1934, arranged as in the previous article—THE ENGINEER, February 2nd, 1934—according to the location of the gauges. Unfortunately, two of the more important London returns, namely, that from the gauge at Ravenscourt Park in the west group and from Golden-lane in the east group, cannot be employed for calculation of the 1933–34 averages. The gauge at Ravenscourt Park developed a defect during the year which necessitated the figures obtained from it being abandoned, and the results obtained from the Golden-lane gauge were so high, being double those of the preceding year, that it was evident some special cause must have been operating to produce such high contamination. The writer has been in communication with Dr. Owens, the Superintendent of the Observations, concerning the Golden-lane figures for 1933–34, and he states that the monthly deposit at this station have been extremely erratic, and that during the year ending March 31st, 1934, one-third of the total deposit for the year occurred in the month of January, and that practically one-half of the whole year's deposit was collected in December and January. It is possible that the large amount of building reconstruction which is taking place in the central and City portions of the Metropolis may be one contributory cause of the very high deposits now being obtained at Ravenscourt Park and in Golden-lane, for the demolition of old property adds enormously to the amount of dust in the atmosphere at ground levels. In calculating the averages for Tables II and III, therefore, the figures for these two stations have been omitted, and only the figures from the gauges that show some uniformity have been employed. The averages for solid matter collected in the gauges located in the east and central districts of London are seen to have increased from 288 tons per square mile per annum in 1931–32 to 318 tons in 1933–34, representing an increase of 10 per cent. in the period under review. The gauges at Horseferry-road, Finsbury Park, and Victoria Park all show increased deposits, while those at Southwark Park and Archbishop's Park show a decrease. As regards the west and south-west districts, the average solid deposit for 1933–34 is 184 tons, as compared with 206 tons per square mile per annum in 1931–32, the figures for each of the gauges being lower in 1933–34 than in the earlier year with the exception of the gauge at Kew Observatory (north), which was the same.

TABLE II.—*The Total Deposit of Sold Matter Collected in the London Gauges During the Three Separate Years Ending March 31st, 1934.*

Locality of gauge.	Tons of solid deposit per square mile per annum. 1931–32.	1932–33.	1933–34.
East and Central Districts—			
Golden-lane	303	344	644*
Archbishop's Park	373	331	346
Horseferry-road	379	327	399
Southwark Park	254	234	243
Finsbury Park	240	233	376
Victoria Park	195	208	226
Averages for five gauges	288	267	318
West and S.W. Districts—			
Ravenscourt Park	472	472	—*
Mount-street	329	291	270
Westminster	252	283	226
South Kensington (M.O.)	229	192	191
Wandsworth Common	182	163	179
Kew Observatory (South)	129	134	120
Kew Observatory (North)	116	115	116
Averages for six gauges	206	196	184

TABLE III.—*The Total Amount of Sulphur Collected by the London Gauges During the Three Separate Years Ending March 31st, 1934.*

Locality of gauge.	Tons of sulphur as SO_3 per square mile per annum. 1931–32.	1932–33.	1933–34.
East and Central Districts—			
Golden-lane	45	46	110*
Archbishop's Park	46	43	38
Horseferry-road	40	29	42
Southwark Park	30	28	31
Finsbury Park	26	28	63
Victoria Park	22	28	23
Averages for five gauges	33	31	39
West and S.W. Districts—			
Ravenscourt Park	105	107	—*
Mount-street	35	39	21
Wandsworth Common	24	26	23
Westminster	23	23	20
South Kensington	27	23	26
Kew Observatory (South)	19	18	18
Kew Observatory (North)	17	16	17
Averages for six gauges	24	22¼	21

* N.B.—The results obtained with the Golden-lane gauge for the year ending March 31st, 1934, have not been used for calculating the averages in these tables. The Ravenscourt Park deposit gauge also during the year develcped a defect which caused the deposit figures for 1933–34 to be abandoned.

Turning now to the consideration of the figures showing the amount of sulphur compounds collected in the gauges, a similar increase of the deposit is revealed by the results obtained in the gauges located in the east and central districts, the average having increased from 33 tons SO_3 per square mile per annum in 1931–32 up to 39 tons in 1933–34, an increase of 18 per cent., the gauges located in Horseferry-road and in Finsbury Park being the chief contributors to this increase. In the west and south-west districts, on the other hand, the amount of deposit of sulphur compounds has been reduced from an average of 24 tons SO_3 per square mile per annum to 21 tons in 1933–34, all the gauges showing a reduced figure with the exception of that at Kew Observatory (north), which is the same. Whether the operation of the Battersea Park power station has been in any way responsible for the higher figures of total solids and sulphur in some of the gauges in the east and north-east of London, it is yet too early to say. It must be remembered in this connection that the prevailing winds in this country are from the west and south-west, and would carry the chimney gases from the Battersea Park power station over the central and north-eastern districts of the city. Although none of the gauges in the immediate vicinity of the station show increased deposits, it is quite possible that some of the finer particles of ash and some portion of the sulphur gases (if any), which have not been removed by the washing apparatus installed at the power station, would be deposited by the rain falling on the eastern and north-eastern sides of the city, and would thus be partly responsible for the increased deposits at Golden-lane and at Finsbury Park.

Table IV contains the figures for the comparative amounts of sulphur collected in nine towns and cities during the three separate years 1931–32, 1932–33, and 1933–34, expressed as tons of SO_3 deposited in the gauges per square mile per annum. The figures show that a steady improvement is taking place as regards this constituent of air pollution. The reduction in the figures for Glasgow and London is striking, and even the Netherfield-road district of Liverpool, which is the worst in this country for air pollution, owing to its proximity to the docks, shows a reduc-

TABLE IV.—*Comparative Amounts of Sulphur Collected in Nine Towns and Cities During the Three Separate Years Ending March 31st, 1934.*

Town or city.	Tons of sulphur as SO_3 per square mile per annum. 1931–32.	1932–33.	1933–34.
Southport	12·6	14·2	10·8
Bournville	12·2	16·6	11·6
Birmingham Central	27·2	—	19·3
Glasgow	37·0	32·5	27·4
London	40·6	41·3	29·5
Leeds (Park-square)	40·0	34·3	24·5
St. Helens	46·5	38·9	32·8
Liverpool (Netherfield-road)	71·2	61·8	54·0
London (Ravenscourt Park)	104·6	107·0	—

tion in the years under review of over 24 per cent. Leaving out of the calculation of averages the exceptionally bad figures of Ravenscourt Park, London, the average sulphur deposit in the remaining towns in the year 1931–32 was equivalent to 35·9 tons SO_3 per square mile per annum, while for the year ending March 31st, 1934, it was equivalent to 26·2 tons, which is equal to a reduction of 27 per cent. in the three years.

Table V contains the figures for the highest and lowest results for total solids and sulphur collected in individual gauges at various places. The Liverpool (Netherfield-road) gauge, as in the preceding year, collected the largest amount of solid matter, and was followed closely by the Burnley Town Hall gauge, the respective figures being 532 tons and 435 tons. As regards sulphur impurities, the Netherfield-road gauge in Liverpool and that installed at Central Hull showed the worst results, the respective figures being 54 tons and 46·2 tons. The fact that ships in port or in dock are exempted from all by-laws relating to air pollution, explains why the ports of Liverpool, Newcastle, and Hull show such bad figures in these returns, and the question arises whether the time has not arrived when this exemption should cease.

Table V.—*Highest and Lowest Results in* 1933–34 *for Total Solids and for Sulphur Acids Collected at Individual Stations.*

Highest and lowest results.	Tons per square mile per annum. Total solids.	Sulphur acids as SO_3.
Group 1: Highest results—		
Liverpool (Netherfield-road)	532	54·0
Burnley (Town Hall)	435	31·8
Ashington (High Market)	411	35·2
London (Horseferry-road)	399	42·4
Sheffield (Surrey-street)	370	26·4
Leeds (Park-square)	342	24·5
St. Helens	315	32·8
Hull (Central)	307	46·2
Castleford	301	17·2
Group 2: Lowest results—		
Southport (Hesketh Park)	89	11·3
Marple, Cheshire	94	18·4
Bournville Village	95	11·0
Wakefield (Clarence Park)	103	—
Halifax (West View Park)	106	13·2
Garston	109	15·2
London (Kew Observatory, N.)	116	16·8
Cardiff	138	13·4
Glasgow (Queen's Park)	166	21·4

As regards the lowest totals of air pollution in Table V, the gauges installed at Hesketh Park, Southport, and at Marple in Cheshire, show the very satisfactory figures for total solids of 89 tons and 94 tons respectively; while the lowest figures for sulphur impurities are recorded by the gauges located at Bournville Village and at Southport, Hesketh Park. The striking cleanliness of the air in the vicinity of some of our larger cities is shown by the figures obtained from individual gauges on the west and south-west sides of London, Glasgow, Cardiff, Halifax, and Wakefield, all of which find a place in the second group of Table V.

The Beama Report.

The report of the British Electrical and Allied Manufacturers' Association for 1934 indicates that the anticipated upward tendency in the output of the electrical manufacturing industry during that year was realised, and all indications for the present year point to continued improvement. There are, however, factors in the situation which still give cause for anxiety. The depression has not been entirely banished. International political debts remain a menace to world recovery. The smooth flow of goods between agricultural and industrial nations, which can provide the only permanent basis of trade revival, is particularly non-existent, and thus the most formidable problem—that of the balance of world economy—is still unsolved.

Within the confines of the Empire, however, some recovery has taken place, but it is due to very special causes. The improvement in both home and export business throughout the whole engineering industry in the past year affords evidence of a distinctly monetary stimulus to trade developments. As a consequence of the formation of the sterling *bloc*, the Empire overseas has taken a considerably higher proportion of electrical products compared with recent years. Almost entirely as a result of the premium on gold, South Africa has become the greatest market for our iron and steel manufactures and for railway material, and is the second greatest importer from this country of general machinery, cutlery, hardware, tools, and scientific instruments. By far the greatest proportion of British electrical machinery exports were consigned to the Union, its imports of British motors being 100 per cent. greater than those of 1933, and of electrical goods and apparatus 100 per cent. higher than in 1932.

The remarkable feature of the electrical export market will probably be considerably influenced by monetary developments. Whilst President Roosevelt's experiments have yet to assume a final form, it would appear that the harmful effects on British trade of the dollar depreciation are being offset by the rise in world prices. It is hoped that the transition period of 1935 with money dominating trade, will be rapidly merged into a definite agricultural revival in all countries, when trade will dominate money. On the emergence of such a period depends the future prosperity of British electrical exporters.

At home the reappearance of the Central Electricity Board in the market for electrical machinery was a welcome manifestation of confidence in the continuance of the public demand for electricity, reinforced as it was by some recovery in the industrial power load. It appears, however, that prior to 1934 new generating plant requirements were under-estimated, and it is hoped that the distribution of new orders will not follow at sporadic intervals and thus increase manufacturing difficulties, but will, as far as possible, be issued at regular periods on a clearly thought-out plan.

While, on the whole, there was a pronounced upward swing in various branches of heavy electrical manufacture, the business was again uneven. In the latter part of the year a revival of the demand for smaller generating plant was noticeable. New converting plant orders remained practically stationary, whilst large turbine business was active compared with 1933. Switchgear business rose considerably; but that in small transformers showed only a moderate increase. Large transformers, nevertheless, experienced a marked recovery, having regard to the abnormally low prices of 1933. There was a considerable increase in the demand for large motors and industrial motors generally. Prices were, however, such that, in too many cases, profit margins were, and are still, reflections of slump conditions, and if provision is to be made for research and technical improvements generally, and the position of the industry as the foremost in the world is to be maintained, those margins will require to be considerably widened.

Producers of smaller apparatus continue to fare satisfactorily, but the 25 per cent. increase in imports compared with 1933 demonstrates the inadequacy of the present duty on accessories, meters, instruments, and carbons. The domestic demand for electricity is advancing rapidly, and the sale of household apparatus has naturally followed this increasing prosperity.

The number of insured workpeople in heavy plant manufacture rose slightly, whilst in wiring and contracting an increase of no less than 22 per cent. occurred, and in electrical cable, apparatus, and lamp manufacture an increase of 6 per cent., illustrating the drift from heavy to lighter types of manufacture, as distribution problems come more and more into the foreground. The total number of insured employees in July, 1934, was 257,830, compared with 243,770 in the preceding year. It is considered to be highly probable that 1935 will witness an even greater extension.

American Engineering News.

American Railways in 1934.

The year 1934 brought an improvement over 1933 in traffic on the American railways, but the situation is still very bad and the outlook is dubious, largely owing to a generally hostile attitude of the public, the labour unions, and the regulating and taxing bodies. Regulations of fares and services in highway traffic are proposed, but are not in effect. What is needed is less regulation of the railways and more regulation of their competitors. Only 76½ miles of new line were built and only 4 miles of additional main tracks; but two lines totalling 42 miles are under construction (both to new dams for the Government) and two totalling 125 miles have been authorised by the Interstate Commerce Commission. About sixty lines, with 42,390 miles are in the hands of receivers and 1995 miles have been abandoned. Since 1917, 15,706 miles have been abandoned and 10,148 miles built, giving a net decrease of 5558 miles. One hundred and sixty-three locomotives were built for domestic lines and seventeen for export, a total of 200. Of the 163, there were seventy-two steam engines, seventy-six electric, and thirty-five oil or petrol engines, including oil-electric. Seven articulated motor trains were built; 388 passenger cars—besides fifteen for export; 24,611 freight cars—including 1335 for export, and seven rail motor cars. For highway service the railways added to their equipment 302 motor coaches or omnibuses, 337 motor trucks, 27 tractors, 20 trailers, and 45 passenger automobiles. Passenger miles increased 8·9 per cent. over 1933; ton-miles, 7·5 per cent.; operating revenue, 5 per cent.; but the operating ratio rose 2·3 per cent. to 75 per cent. of earnings. Automatic block signals were installed on 164 miles, and eighteen new interlocking plants, with 307 levers. With deferred work and the improvement of railway affairs it is expected that there will be considerable activity in signal and interlocking work in 1935, and for the next few years. Great changes in operating methods will be necessary to develop additional passenger traffic and to reduce the present excessive expense of passenger service. Faster trains of normal type and high-speed motor trains are likely to be increased materially.

Steel Developments in America.

According to official statements, the output of steel products in 1934 showed a general increase over 1933. Ingots totalled 25,260,570 tons (an increase of 10·4 per cent.); rails, 1,007,746 tons (147 per cent.); fish-plates and track materials, 1,178,666 tons (17 per cent.); structural shapes, 1,048,077 tons (42 per cent.); bars, 2,189,248 tons (3 per cent.); bars for concrete reinforcement, 401,986 tons (29 per cent.); black plates and sheets—except for tinning—2,496,317 tons (14 per cent.); galvanised sheets, 780,709 tons (20 per cent.); strip steel, 1,907,194 tons (27 per cent.); tubes and pipes, 1,565,524 tons (50 per cent.); all other finished rolled products, 245,841 tons (29 per cent.). The only two classes in which there was a decrease were black plates for tinning, 1,418,182 tons (a decrease of 19 per cent.), and wire products, 1,254,060 tons (9 per cent. decrease). It is reported also that extensions and improvements to steel works, as planned for 1935, will amount to some £25,000,000. The great demand for flat rolled material for automobile bodies is largely the cause of the introduction of continuous sheet mills and developments in the rolling of steel shapes. In 1934, the automobile industry consumed 55 per cent. of the output of strip steel, 42 per cent. of bars, 10 per cent. of wire products, and 5 per cent. of pipes and tubing. The increase in 1934 steel production was due in large part to Government financing, especially for rails and track material, so that it is said to represent artificial stimulation rather than expansion of private demand. Many types of steel houses have been designed but there is no prospect of their construction in large quantity, and their economy lies in mass production—not necessarily identical in outward appearance. However, interior steelwork, such as partitions, stairs, &c., may be used in buildings of ordinary types. Stainless steel tanks for petrol on a Navy vessel have been replaced by galvanised steel owing to severe corrosion caused by petrol and salt water under the hydrostatic system of operating the tanks.

High-speed Railway Track.

With the increase in train speeds on many American railways, by regular equipment as well as by streamlined oil-engined trains, there comes the necessity of considering the condition of the track for unusual speeds, both as to comfort and safety. Of particular importance are the radius and superelevation of curves. The superelevation is a problem, since trains of various speeds have to be considered. Transition curves or spiral connections between tangents and curves, though largely used now, become even more essential. In studying the relations of track to the "Zephyr" articulated streamlined train of the Burlington Railroad, with an average speed of 72 miles an hour and a maximum of 90 miles per hour, it was concluded that the highest speeds could be maintained on curves of 2 deg.—2865ft. radius—where the transitioning and superelevation were suitable. For curves of 5730ft. radius, with superelevation increased from 2in. to 2½in., speeds of 90 to 95 miles an hour would be both comfortable and safe. For a radius of 1432ft., the present 3½in. elevation is sufficient for comfortable riding at 51 miles an hour. Certain parts of the line are specified for certain speeds, and curves are adjusted to the limiting speed of that part of the line. In some places the line has been rebuilt to eliminate sharp curves. The fast trains have little effect on track maintenance, partly, no doubt, on account of the light weight. But the track is already of heavy construction. One of the very important items in track maintenance for light, high-speed trains is to maintain an even or "sand-papered" surface, as even slight variations in line and level—on tangents and straights—may cause uncomfortable riding.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

BRITISH STANDARD SPECIFICATION FOR PORTABLE CHEMICAL FIRE EXTINGUISHERS OF THE ACID ALKALI TYPE.

No. 138—1935. The British Standards Institution has issued a revision of the British Standard Specification for Portable Chemical Fire Extinguishers—No. 138—the original edition of which appeared in 1922. The Committee responsible for the preparation of this specification is now proceeding with the preparation of two new specifications for portable fire extinguishers of the foam and carbon tetrachloride type.

ELECTRICALLY WELDED MILD STEEL CHAIN SHORT LINK AND PITCHED OR CALIBRATED.

WROUGHT IRON AND MILD STEEL HOOKS OF THE "C" OR LIVERPOOL TYPE.

No. 591—1935. The British Standards Institution has just issued a specification for Wrought Iron Hooks of the "C" or Liverpool type. This specification is a parallel specification to that prepared under the reference No. 482—1933 for Hooks for General Engineering Purposes, and forms one of a series which comprises terminal fittings of chains and wire ropes used for lifting purposes. Details of the form of hook are given, together with a complete table for hooks for sizes from 1–10 tons. The hooks may be made either from mild steel or wrought iron and clauses are included covering quality of material, workmanship, freedom from defects, heat treatment, and testing. The specification, which has been prepared by a committee of users and experts under the chairmanship of Mr. A. L. Haas, M.I. Mech. E., of the India Store Department, has involved extensive experimental work, and the Committee entrusted with its preparation is indebted to the National Physical Laboratory for theoretical investigations and experimental work involved in determining the proportions, dimensions, and strengths of the hook specified.

No. 590—1935. The Institution has also issued another new specification for electrically welded mild steel chain and pitched or calibrated chain. Two qualities of chain are provided for, "standard quality" and "special quality," which may be ordered polished or unpolished. The specification gives full details of the design of the links together with a table of dimensions for sizes varying from 6 S.W.G. to 17/32nds of an inch, representing a range of maximum permissible working loads of from 4 cwt. to 1 ton 14 cwt. respectively.

BRITISH STANDARD SPECIFICATION FOR PUMP TESTS.

No. 599—1935. The British Standards Institution has just published a Specification for Pump Tests, designed to cover the determination of the performance and efficiency of pumps when handling clean water at temperatures up to 85 deg. Fah. The specification has been based on the Standard Pump Test Code of the Standards Association of Australia, and sets out the mechanical and hydraulic conditions to be observed and precautions to be taken during a test. Tables giving the discharge over 90-deg. and half 90-deg. vee notches are included. Appendices have been included outlining the information which should be supplied to makers with inquiries or orders and giving a suggested standard form of pump test sheet which incorporates all the information usually required. A table of water densities at various temperatures is also included for the convenience of users, together with notes on centrifugal pump characteristic curves.

Rail and Road.

A PASSENGER train of four coaches, when running at full speed over the Swadlincote single line, near Burton-on-Trent, L.M.S.R., on the night of Wednesday, March 20th, was wholly derailed. There were no personal injuries. The cause has not yet been made public.

WE regret to hear of the death, on March 23rd, of Mr. Edward Treacher, one of the permanent way assistants to the chief engineer, Southern Railway. Mr. Treacher was for many years an active member of the Permanent Way Institution, for which body he acted as Hon. Editor of its "Proceedings."

IN the Port Eglinton Junction accident report, which was reviewed in our issue of February 22nd, it was said that the proportion of electrically lighted passenger stock for steam-hauled trains on the L.M.S. system had increased from 52 per cent. at the end of 1928 to 79 per cent. at the end of 1933. We would add that 1928 was the year of the Chesfield disaster.

EARLY on Sunday morning, March 24th, work began upon the replacement of the main girders of the Burleigh Bridge, which carries the L.M.S. main line from London and Derby to Manchester, over the river Derwent between Derby and Duffield stations. Two giant steam cranes were employed, and out of a total of 600 tons of steelwork required for the bridge, 245 tons were got into position. There are four tracks over the bridge, and one of them was kept open for trains throughout the operations.

THE late Mr. Walter Hudson, who died on March 18th, at the age of eighty-three, had the advantage, when discussing labour questions with the railway companies, of having been in the service of the North-Eastern Railway for twenty-six years. He was the President of the Amalgamated Society of Railway Servants from 1892 to 1898, which body had previously, since its formation in 1872, had public men, interested in railways, as the President. Mr. Hudson was a member of the 1899 Royal Commission on Accidents to Railwaymen and of the 1914 Departmental Committee on the same subject. He was one of the Members for Newcastle-on-Tyne from 1906 to 1918.

AN article by Mr. Charles E. Lee in the March issue of the *Railway Magazine* on the evolution of the sleeping car, prompts us to mention two railway accidents in which those vehicles early played a prominent part. On November 22nd, 1876, a down express passenger train was wholly derailed, owing to weak permanent way, at Heeley, on the Midland Railway. The subsequent Board of Trade report on the accident spoke highly of the way in which the Pullman cars withstood the shock of the derailment, and kept alignment. At Hunslet, on the same railway, on October 29th, 1882, a Pullman sleeping car was found to be on fire, and the occupant of the berth in which the fire broke out was burnt to death. He had been smoking a cigar, and it was recorded in the Board of Trade report that he was either under the influence of drink or of some stupefying drug.

ON the evening of Thursday, March 21st, there was another collision between a passenger train and a motor car at a level crossing, but, fortunately, without serious personal injury. The accident is, though, of more than ordinary interest in that it was (1) at a public road level crossing; (2) on a light railway and therefore not provided with gates; (3) at Jacob's Gutter-lane, near Fawley, Southern Railway, where there was a fatal similar mishap on July 26th, 1933. The latter accident was inquired into by the late Colonel Anderson, whose report was reviewed in our issue of November 17th, 1933. The motor vehicle on that occasion was going from Marchwood to Totton, which was the same direction as the motor car was proceeding on March 21st. Reference to our comments on Colonel Anderson's report will show that there was no justification for the erection of gates.

FROM the evidence given at the coroner's inquest of March 19th on the driver killed in the King's Langley quadruple collision of March 13th—when a verdict of "Accidental death" was returned—and at Colonel Mount's Ministry of Transport inquiry the following day, it would appear that the original collision between the meat train—which had been delayed in the section by a brake failure—and the milk train was caused by the signalman at King's Langley irregularly clearing his block instrument for the former train and accepting the latter. The King's Langley man had it in his mind that the meat train had not passed, and his train register confirmed that opinion, but when the Nash Mills signalman said that he was waiting for the meat train to be cleared and to send forward the milk train, he incorrectly assumed that what was in his mind and the record in the train register were wrong.

THE London and North-Eastern report for 1934 shows that the gross receipts from railway working were £44,913,974, and the expenditure £36,932,444, as compared with £42,687,504 and £35,211,321 respectively in 1933. Practically the whole of the increase in expenditure is to be found in £1,220,987 more having been spent on the maintenance and renewal of rolling stock, where 17·95 per cent. of the total receipts has been expended, as against 16·03 per cent. in 1933. The "Review of the Company's Business" that accompanies the report, observes on this point that for some years the directors have reduced the expenditure on rolling stock as far as possible, as, in view of the great decrease in traffic receipts since 1929, there was some doubt as to the extent of the ultimate requirements. The policy of the Board had been to maintain in efficient condition the requisite amount of rolling stock of all kinds for the traffic offering, but the considerable improvement of trade during the last eighteen months has altered the position and made the provision of new rolling stock imperative. On the whole of the expenditure the ratio to receipts was less than in 1933—82·23 as against 82·49. The number of passengers carried during the year was 193,035,874, at an average fare of 1s. 0·49d., as against 186,900,207 at the same average fare. The tonnage of freight was 124,260,521, at an average of 4s. 6·12d., as compared with 113,981,152 tons at an average of 4s. 7·11d. per ton.

Miscellanea.

THE new brewery of Guinness at Park Royal, London, will start work early in July.

THE Scottish Co-operative Wholesale Society proposes to erect a mill for the manufacture of all classes of paper.

THE Penistone Steel Works, which have been shut down for 4½ years, have been acquired by David Brown and Sons, Ltd., of Huddersfield, and are to be reopened for the manufacture of heavy castings.

THE Chinese Ministry of Communications has placed a contract with the Marconi Company for seven short-wave stations to form part of a network of new wireless communications services linking up the principal cities and commercial centres of China. The transmitters to be supplied will be suitable for the economical operation of a wide variety of services, being capable of communication on either telephony or telegraphy and incorporating special arrangements for rapid and easy wave length changing.

MR. W. A. ROBERTSON, Director of the Forest Products Research Laboratory of the Department of Scientific and Industrial Research, speaking at the annual luncheon of the Federated Home-Grown Timber Merchants' Associations on March 13th, referred to the possibility of growing Corsican Pine in this country without knots. He mentioned that experiments were being conducted on questions of soil and pruning, for it appeared that freedom or otherwise from knots might have some close relationship to these aspects of sylviculture.

IT is announced that the Kelvin Medal Award Committee has awarded the Kelvin Medal for 1935 to Sir John Ambrose Fleming, M.A., D.Sc., F.R.S., in recognition of his services to electrical science and particularly of his invention of the thermionic valve. The presentation ceremony is expected to take place in the Great Hall of the Institution of Civil Engineers early in May. The Kelvin Gold Medal is awarded triennially as a mark of distinction in engineering work or investigation of the kinds with which Lord Kelvin was especially identified.

THE lapel microphone—only the size of a half-crown and weighing 1½ oz.—is clipped to the speaker's lapel, giving him freedom to move to any position on the stage. It overcomes the restrictions present with the use of the stand type microphone and permits the speaker to inject natural personality into his speech, and allows characteristic mannerisms and movements to be employed with perfect freedom, without affecting the efficient pick-up qualities of the instrument. After-dinner speakers will be grateful to the Western Electric Company for producing it.

KRANGEDE water power station, utilising the Krängede Falls, is now nearing completion, and will then be the biggest in Sweden. A great part of the work has been done by blasting out of virgin rock. The machine room is 50 m. deep in the rock, and there is a tunnel in the rock 1400 m. long, 11 m. wide, and 13 m. high. The dam over the river Idalsälven, in which lie the Krängede Falls, is claimed to be one of the largest concrete dams in the world, with a length of 215 m. For the present only some 60,000 kilowatts are installed in two turbo-generator units, but there is space for six, and when these are in place the Krängede power station will be the largest in Sweden.

IT is well known that the sounds produced by explosions are sometimes heard at very great distances even when no sounds are to be heard at points comparatively close to the origin. This phemonenon has attracted the interest of meteorologists for a paradoxical reason—whilst the wind carries sound with it to moderate distances (and this is readily explained), the transmission to greater distances—100 miles or more—seems to be independent of the weather. For closer investigation microphones are used which record not only sounds which can be heard, but also infra-sonic waves which are too deep for perception by the human ear. By such means it is proved that when sounds are heard at great distances the energy has traversed the atmosphere at levels far above the highest mountains. The maximum height of the path along which the energy travels is generally comparable with 25 miles. There is good evidence that at such a height the air is warmer than on the ground.

THE history of evaporation, which is briefly sketched in a brochure entitled "One Hundred Years of Chemical Engineering," published by George Scott and Son (London) Ltd., is typical of the history of chemical engineering during the last hundred years. Progress during the latter part of the period has been increasingly rapid. It has been largely due to the replacing of the older view that each industry consisted of a set of manufacturing problems bearing little relation to those of any other industry, by the conception of chemical engineering as a number of unit operations employed in different industries. With this conception it is a matter of course to apply the experience gained in carrying out a chemical engineering operation in one industry to other industries employing the same operation. Every such application involves the study of new factors, and adds to the sum total of knowledge concerning the particular operation. From this point of view breadth of experience in chemical engineering is no less important than length of experience.

AT the annual meeting of the members of the Engineers' Club held at Manchester on Tuesday, March 26th, Mr. Loris E. Mather, chairman of Mather and Platt, Ltd., was elected President to succeed Mr. Bertram Thomas. Mr. E. Royle was appointed Honorary Treasurer in place of Mr. J. Owden O'Brien, who has resigned after filling this post for seventeen years, and Mr. H. Richardson was reappointed Honorary Secretary for the eighteenth year. The Club has now been established for twenty-one years, and it is intended to celebrate the coming of age at a dinner to be held on October 14th next, at which Sir Andrew Duncan, Chairman of the British Iron and Steel Federation, will be the principal guest. The Engineers' Club has filled a much-felt need as a meeting-place for engineers in Manchester, and the leading engineering societies hold their meetings in the Club rooms. Although its membership has fallen during recent years in common with the general experience, it is felt that the lean period has now come to an end, and that a more prosperous time is ahead.

Air and Water.

THE French Minister of Posts and Telegraphs has decided to sign a contract with "Air Bleu" for the establishment of internal air mail services all over France.

THE Dutch Government intends to give financial support to the Holland-America Line for the building of a new 30,000-ton liner to be built in a Dutch shipyard, at an estimated cost of £1,140,000.

IT is expected that the new oil electrically propelled paddle ship being built for the London and North-Eastern Railway for service on the Clyde will be put into service in June next. She will be 215ft. long, 27ft. 6in. beam, and have a service speed of 17 knots.

AN agreement has been signed by the United States Government and the United States Lines whereby the company has contracted to build a sister ship to the 24,000-ton liners "Manhattan" and "Washington," and is allowed to withdraw the "Leviathan" from active service.

THE production programme of the de Havilland Aircraft Company for Gipsy engines is at the rate of thirteen 130 h.p. Gipsy Majors and seven 200 h.p. Gipsy Six per week. The production of the latter engine will be increased to eight engines per week from the beginning of April. The two hundredth Gipsy Six engine and the thousandth Gipsy Major have already been delivered.

GOOD progress is being made on the fitting out of the Cunard White Star liner "Queen Mary." Her twenty-four water-tube and three double-ended cylindrical boilers have been placed in position in the five boiler-rooms; turbines, gear-cases and turbo-generators are being lowered into position; the three funnels have almost been completed ready for lifting on board, and the masts are ready to be stepped.

A RECENT report says that preparations are being made for an experimental "air-train" flight from Moscow to Irkutsk, a distance of over 3000 miles. The "train" will consist of an aeroplane towing nine gliders, any one of which may be uncoupled at a given place and brought to earth by its own pilot. If this trial flight is successful, regular services of "air trains," mainly for fast freight and postal conveyance, will be established.

THE Royal National Lifeboat Institution has received a gift to provide a motor lifeboat in celebration of the King's Silver Jubilee. The boat is to be finished in June and named "Royal Silver Jubilee, 1910–1935." The craft is the first of a new type of motor lifeboat, lighter than any at present on the coast. She will be 32ft. long, weigh 3½ tons, and be driven by two 10 h.p. engines. Instead of having ordinary propellers, she will be fitted with a Hotchkiss internal cone propeller.

IT is announced that the first regular air service for passengers between London and Brisbane will leave Croydon on April 13th. The corresponding service in the opposite direction is due to start from Brisbane on April 17th. Passengers have already been carried on those sections of the route between London and Singapore and between Brisbane and Darwin, but not on the section which includes the 500-miles' crossing of the Timor Sea and the flight over the East Indian Islands.

PARTICULARS of what is probably the most powerful aerial beacon in the world, erected 75ft. above the topmost floor of the Palmolive Building, Chicago, are given in *Flight*. A high intensity arc lamp, giving a 2000 million candle-power light from a 5ft. diameter reflector, makes two revolutions a minute, and is visible from a distance of 200 to 250 miles. A second fixed lamp placed below the beacon is trained on the Chicago airport. The beacon was a gift by the late Dr. E. A. Sperry, and a sum of 132,000 dollars was spent on its installation. The operating costs are some 15,000 dollars a year, which includes the electricity bill of 3000 dollars.

ANSWERING a question in the House of Commons as to how many motor-driven coastal vessels had been constructed in the shipbuilding yards of this country in each of the last three years, and whether there was any information as to the extent to which the coastal traffic on the East Coast was being captured by Dutch vessels of this type, specially built to operate in our waters, the Secretary to the Board of Trade said that there were 12 motor vessels between 100 and 1000 tons built in this country in 1932, 16 in 1933, and 26 in 1934. Dutch vessels competing in the coastal traffic on the East Coast amount to less than 1 per cent. of the tonnage operating in that trade.

THE plant of Armstrong Whitworth and Co.'s three shipyards on the north bank of the Tyne, acquired by National Shipbuilders' Security, Ltd., was expected to be sold by auction on March 25th, but it now appears, says *Shipbuilding and Shipping Record*, that only two of the yards are to be entirely dismantled, namely, those which used to be owned by the Tyne Iron Shipbuilding Company, Willington Quay, and W. Dobson and Co., Walker. Armstrong Whitworth and Co.'s old yard at Low Walker is to be retained practically as it is in case of emergency. The other two yards are going out of existence altogether, and Eltringham's yard at Willington Quay is also to be dismantled.

AN official announcement has been made by the Cunard White Star Line to the effect that the "Mauretania" is to be disposed of. Representatives of ship-breaking firms, foreign operators, and agents of British interests have inspected the vessel, and her future will remain in doubt for some days. Meanwhile, says *The Times*, the Cunard White Star Company are arranging to take the "Olympic" out of the regular Atlantic schedule of sailings. She has but one more voyage to make before she proceeds to an idle berth, where she will remain until the end of June, when she will leave for America to undertake a series of pleasure cruises. The service will be maintained by the "Berengaria," "Majestic," and "Aquitania," and the "Britannic" and the "Georgic" will be transferred to the London and Southampton service to maintain a fortnightly Saturday sailing to New York, the first sailing to be made on April 20th from Southampton.

HYDRO-ELECTRIC POWER STATION AT CARDANO, ITALY

(*For description see page 334.*)

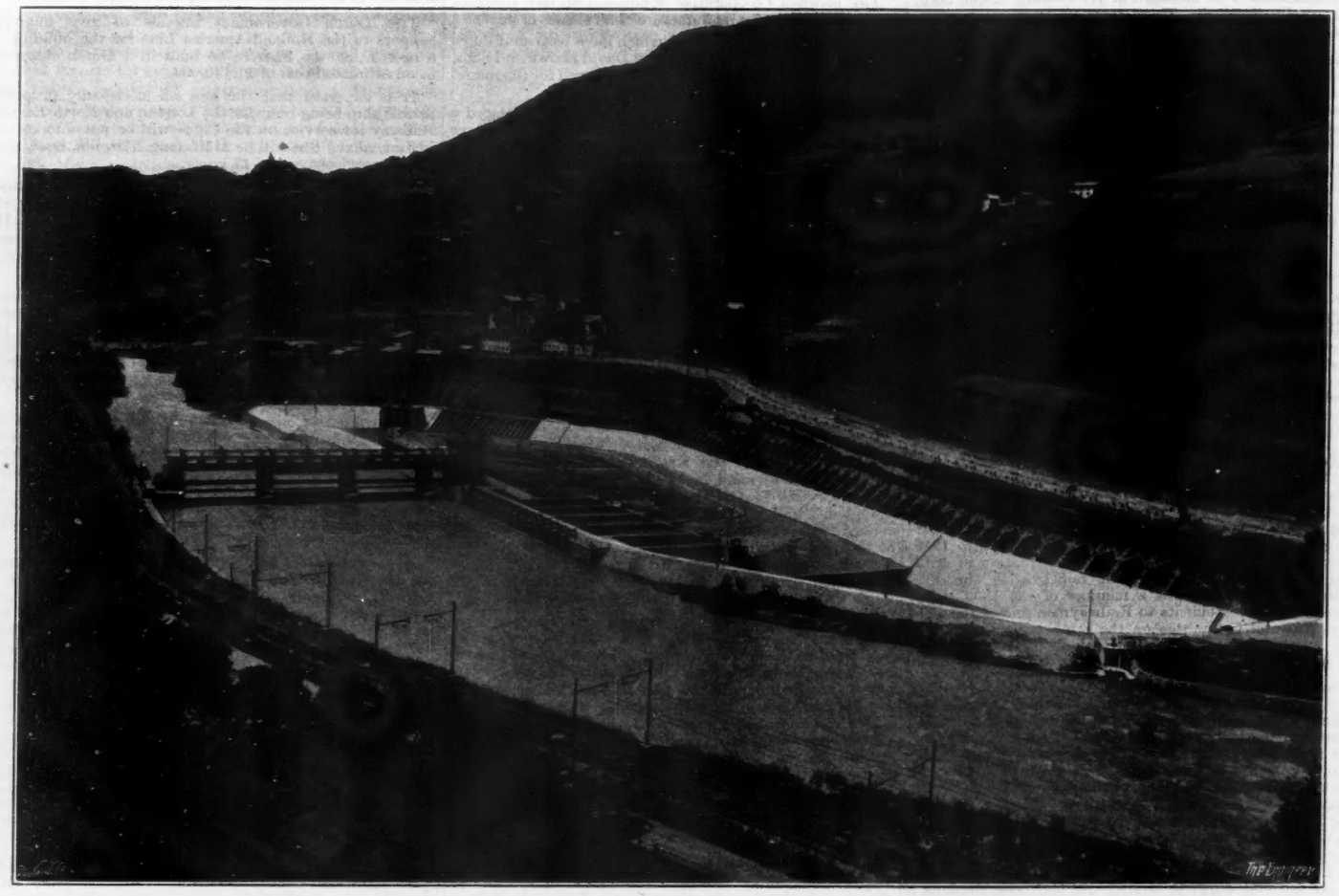

FIG. 1—GENERAL VIEW OF THE STORAGE BASIN AND SAND REMOVAL PLANT

FIG. 2—GENERAL VIEW OF THE "CARLO CICOGNA" POWER STATION

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NOTICES TO READERS.

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WHAT IS STANDARDISATION?

WHAT can be pleasanter than listening to arguments which you are prepared to answer! Thereby two of man's primary instincts are satisfied at once—destruction, by the demolition of your opponent's case, and creation, by the substitution of your own. Hence we print to-day with genuine happiness a letter signed by Mr. R. Dumas, in which we are taken to task for a leader on Standardised Worm Gears, published in our issue of March 8th. Our happiness is not clouded at all by any feeling of contrition, and its perfection is only marred, momentarily we hope, by the thought that we may have wounded the susceptibilities of a handful of gentlemen for whom we have, indeed, the highest regard. The letter speaks of an "attack on the work of the Gears and Gearing Committee of the Mechanical Industry Section of the British Standards Institution." Before we say what must be said about the remainder of the letter, we desire to assure Mr. Dumas that not for a moment did we "attack" the Committee over which he presides with marked ability. If we made an attack at all—and we deprecate the use of such a pugnacious word in this connection—it was upon the policy of the Institution—a matter for which one of its Committees can not be held responsible.

The British Standards Institution has changed its vocation with its name. It began as a Committee, found incorporation as an association, and, a few years ago, was chartered under the Royal seal as an Institution. We are confident that it will not repel the designation of a "national" institution. It has raised itself to that position, and must take the consequences. The affairs of a corporate body enjoying that high distinction are rightly a subject for discussion by any citizen, and we submit with the humility which characterises the Press when it has the temerity to say what it thinks and what it knows much of its public thinks, that the policy being pursued by the B.S.I. ought to be understood by all who take a lively interest in the industrial economics of their country. Therefore we held, and still hold, that we did no more than our plain duty in discussing the standardisation of a product which, in our opinion, does not patently call for standardisation; and in suggesting that that was an example of activities of the Institution which ought to be submitted to careful examination. No one, except the Institution, which is rather sensitive to the least breath of criticism, would regard that, surely, as an attack upon one of its committees. But we must not labour an unprofitable point. Let us rather pursue the letter signed by Mr. Dumas through its course. It recites at some length the work undertaken by the Gears and Gearing Committee, and then continues: "The next specification and the one more immediately under criticism is that on Worm Gearing." Not a word had we said, even by implication, about the other specifications, and we are consequently obliged to regard "more immediately" in a purely Alicean sense. "Take some more tea," the March Hare said to Alice, very earnestly. "I've had nothing yet," Alice replied in an offended tone, "so I c'a'nt take more." "You mean you c'a'nt take less," said the Hatter; "it's very easy to take more than nothing." But passing 'more' as a mere epistolary slip, we observe with satisfaction that the Gear and Gearing Committee realised "that this particular class of gear [worm gearing] was in a somewhat different category," which is exactly what our Leading Article implied. But the letter goes on: "After a careful review of the problem, they [the Committee], nevertheless, came to the conclusion that a measure of standardisation was possible and desirable along the same lines" as the preceding specifications. Is not this an admission that the Committee itself did not feel any imperative call for the Worm Gear specification? Which, again, is just what our article implied. The Committee "after a careful review" came to the conclusion that a measure was "possible and desirable"; not that it was a real necessity. Is it not clear that the Committee recognised that the subject was on the border line, but desired to round off its series on gears and gearing by including a specification? The last paragraph of the letter humiliates us, for from it it is manifest that the writer has not done us the honour to pay attention to our words. There is nothing whatever in the last few sentences of our article of March 8th to suggest that the annual grant of the Institution of Mechanical Engineers was reduced because of dissatisfaction with the standardisation of worm gears. The trouble does not lie in a particular specification, but in the policy of the B.S.I. Furthermore, we are quite unable to see why the Council of the Institution should be expected to refuse an excellent paper on worm gears because it thought—if it did so think—that standardisation was not called for in that instance.

The real marrow of the whole matter is contained in the following paragraph: "The arguments against the standardisation advanced in the Editorial are, in the opinion of the Technical Committee, definitely unsound. First, although a few manufacturers are responsible for a large proportion of the total output of worm gears used in this country, there still remain a very large number of engineering firms who make worm gears for their own purposes. My Committee recognise the fact that many worm gears are designed on a hit-and-miss basis, and one of the main objects of the specification is to place within the reach of industry dependable information regarding efficiency, load-carrying capacity, necessary limits of accuracy, and so forth." If the action described in the last sentence is the proper duty of a standardising body, what is standardisation? If the view conveyed by the words quoted represents the interpretation put upon standardisation by the B.S.I., then there can, we submit, be no question, in spite of the ingenious precedents which it makes for itself, that the Institution is going far outside the generally understood function of such an institution. It is aiming not alone at the production of industrial standards for the benefit of industry by the reduction of unnecessary patterns, but at the publication of theses and data which are ordinarily found in text-books or in the proceedings of learned societies. But with this difference, which the Institution cannot evade, that the "recommended practice," as the letter calls it, of the B.S.I. must, in actual fact, bring about a standardisation of that practice, or, as Dr. Merritt implied, fail in its purpose. The text-book binds no one; a specification issued by the national standardising body binds everyone. That is a very serious and important difference. Hence this is one of the items in the policy of the Institution which needs to be discussed, to quote our own words, for "approval or modification." Had the Institution of Mechanical Engineers, let us say, set up a committee to examine and report upon Worm Gear Design, we should have had nothing but unstinted praise for its enterprise. But what may be done by a learned society without disadvantages, may have many when done by a standardising body, and in any case is, we repeat, outside the generally accepted functions of such bodies.

The New British Steel Duties.

A SHORT time ago the British steel industry appeared to be regarded with a certain amount of disapprobation by those in authority, and we became used to hearing exhortations addressed to the steel makers to "set their house in order." Now, the Import Duties Advisory Committee has given the makers all they asked in the way of duties and included a few kindly pats on the back. For instance, in its recommendation to the Government to increase the duties, which has been published as a White Paper, the Committee expresses its pleasure at the "notable advance" made by the appointment of an Independent Chairman and the affiliation of a number of associations to the Federation. The new duties, which came into force on March 26th, are based on a flat rate, and at present prices would appear to work out at from 50 to 65 per cent., as against the 33⅓ per cent. previously in operation. In pointing out that the increased duties will apply "to some of the principal elementary iron and steel products," the Committee barely does justice to their scope, as they apply to all the most generally used descriptions of iron and steel. There had been a progressive diminution of imports until last year, when there was an increase to 1,366,660 tons from 970,830 tons in 1933, the imports from foreign countries rising by 36 per cent. from 848,928 tons to 1,157,519 tons. Stress is laid upon the desirability of agreement between the British steel makers and the Continental Steel Cartel, which should provide "for agreed and regulated imports" of Cartel products, and for the "regulation of competition in export markets to the advantage of both parties." The Committee also contemplates the admission of imports on terms which would "give the Continental producer a better price than he obtains at present in this market, without making such steel too expensive" to British consumers.

For the first time it is revealed in the White Paper that the British offered the Cartel, with the approval of the Import Duties Advisory Committee, a quota for the British market not exceeding 643,000 tons, which was the total of the imports from Cartel countries in 1933. The counter proposal "did not provide for more than a small reduction on the 1934 imports." The Committee therefore regretfully came to the conclusion that further progress for the iron and steel industry "cannot for the moment be provided for under international agreement, and that it is necessary to resort to increased duties." It is permissible to regret that it was not considered necessary to indicate the nature of the objections which were urged against an increase. It is not difficult to imagine some of those which would occur to the sections of industry and commerce affected, and, indeed, the Committee seems to have been alive to certain aspects of the situation. It recognises that "sections of the industry have gained, particularly in the export markets, by the use of cheap foreign steel; but these sections have already in a great measure turned over to the use of British material, and, subject to reasonable assurance as to the future course of prices, they are in the main not opposed to the objects we have in view." The question of price-cutting is referred to, and it is argued that on a sterling basis price reductions on foreign steel have exceeded 33 per cent., whilst in the currency of the countries of origin the decline has reached 60 per cent. or more. On the other hand, the Committee realises that in many cases the new rates of duty may offer an opportunity to home producers to increase prices, and they "are fully alive to the danger of exploitation." The opinion is expressed that there is no reason why British prices should be advanced in the absence of increases in the cost of production, particularly in the cost of scrap and coke. In fact, it is suggested that the increased home production and improved equipment and organisation which should result from the policy recommended by the Committee should assist in reductions at an early date. These are apt remarks, as there is no doubt that the trend of prices under the new dispensation will be a source of anxiety to consumers for some time. And with good grounds, for there have already been considerable advances in British prices. Two years ago 18 g. wire cost £25 10s. per ton; it now costs £32 10s., a rise of £7. Hot rolled hoops in November, 1932, cost £7 17s. 6d., and have advanced £1 10s. to £9 7s.; whilst cold rolled hoop, which

eighteen months ago could be obtained for £13 2s. 6d., is now quoted at £14 10s., a rise of £1 7s. 6d. An advance has also taken place in the price of steel bars, which when the duties were first brought in could be bought at as low as £6 5s., but are now officially quoted at £8 14s. 6d. The price of boiler plates has been advanced £1 5s. to £9 10s., and sheets 24 g. C.R.C.A. from £8 15s. to £10 15s. It would be well for them if consumers could share the confidence of the Committee which favours a price policy aiming at large outputs and low prices. "As a guarantee of such a policy being pursued," importance is attached to the fact that the Federation was framed to "secure when fully in operation a reasonable balance between the producing and consuming interests on its governing bodies."

It is not disguised that the new duties are designed to provide a weapon for the British steel makers to negotiate a satisfactory quota in the export markets, in addition to giving them the control of the home market. This is a bold tactical plan, and it will be interesting to watch the extent of its success. This month the British and Continental steel makers met at Cannes, and all accounts dwelt upon the friendly atmosphere that prevailed. The Continental steel makers, however, appear to have been under the impression that the duties would not be raised until the result of the negotiations, either for good or bad, had become apparent, and the necessity for readjusting this view may bring about interesting reactions. According to reports, the various industries affected have appealed to their Governments to make representations against the duties, so that the fortunes of the British steel trade may become more than a national political problem. In this country also the references in the Committee's recommendations to the nature of the agreement between the Federation and the Cartel will cause some uneasiness. Even if the question of a quota for the British market were settled, the need for some machinery to supervise the imports is considered necessary. The British view that the Federation might take over the merchanting of the whole of the Continental imports to the exclusion of the firms which now handle this business was rejected by the Continent. It is understood that a counter-proposal was made by which the Continental selling organisation in this country would be responsible for this work. In either case British firms would be in danger of being put out of business in the home market. Pending further developments, it is interesting to note that the practical effect of the tariff is to raise the price of Continental joists d/d London to £8 0s. 6d., compared with £6 13s. under the old duty, the British price d/d London being £8 17s. 6d., less a rebate of 22s. 6d. For Continental angles the price under the old tariff was £6 11s., compared with £7 10s. under the new duty and £8 10s. for similar British material, less a rebate of 15s.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

STANDARDISED WORM GEARING.

SIR,—The attention of my Committee has been called to the leading article appearing in THE ENGINEER for March 8th under the above heading. This leading article appears, in our opinion, to be based on an entire misconception of our work. We construe it as an attack on the work of the Gears and Gearing Committee of the Mechanical Industry Section of the British Standards Institution, and, therefore, in all fairness to our members, who have devoted much time and thought to the service of industry in the production of this specification, I would ask that you be so kind as to give publicity to this reply.

The criticism gives the impression that the B.S.I. is an outside body arbitrarily interfering with industry and attempting, in this case, to impose unwanted standards upon manufacturers and users, which is quite at variance with the facts. The Gearing Committee was only appointed after the usual procedure of the B.S.I. had been followed, which involved consideration by the Mechanical Industry Committee (upon which the Institution of Mechanical Engineers is strongly represented), and also by a representative conference of users and makers, as to whether the proposed standardisation was, or was not, desirable. The Gearing Committee—as is usual with these committees—is fully representative of all the interests involved, namely, users, manufacturers, consultants, and research.

The Committee, after careful consideration of the task set before them by the Industry Committee, decided to tackle their work in stages, and, in the first instance, devoted themselves to the preparation of a Specification for Helical and Straight Spur Gearing. This specification dealt with the subject fairly comprehensively and included definitions and nomenclature, form of teeth with permissible errors for various classes of gears, the proportions of gears and the strength and horse-power capacity. The scope of this work is, therefore, by no means confined to the purely dimensional side of the question as effecting interchangeability, but, more important, a standardised basis is provided for the calculation and design of gears which can be relied upon to give good life and operating results for a wide range of working conditions. From this latter standpoint there is no doubt that the specification has met a real demand, and this is evidenced by the very large sales which have taken place and the many inquiries and letters of appreciation which have been received from all parts of the world.

It will be seen, therefore, that the character of the standardisation effected, while it may differ in some respects from the dimensional standardisation of specific components, does establish standards in respect of quality and excellence of product.

The Committee subsequently proceeded with the preparation of a Specification for Bevel Gears, this following very much on the same lines as the Helical and Straight Spur Gear Specification. It can be said that this also has met with similar appreciation from the engineering industry.

The next specification, and the one more immediately under criticism, is that for Worm Gearing. The Committee, at the outset, realised that this particular class of gear was in a somewhat different category. After a careful review of the problem they nevertheless came to the conclusion that a measure of standardisation was possible and desirable along the same lines, namely, that a specification should be prepared for gears required to operate under particular conditions which would result in such gears being properly proportioned so as to give satisfactory service and a reasonably long life. The choice of the particular form of thread followed on quite naturally and logically from what had been decided in connection with the two previous specifications issued, the modification in the form being quite slight, and it is also true that it has certain advantages from a design and measurement standpoint.

The involute helicoid type of thread can be produced on worm grinding machines which allow of the grinding being effected by the flat side of the wheel and on other machines with a suitably shaped wheel.

Moreover, the Committee have in no way tied industry, or themselves, to this particular form of thread. They have only put it forward as recommended practice and have admitted other forms, subject to their giving correct conjugate action and, of course, subject to the limitations imposed by the clause which deals with interference. This has been stated quite clearly in the Foreword.

Consequently, the specification does not in any sense curb the activities of manufacturers or prevent them from using other forms of thread, nor does it in any way put a bar upon the production of still further forms should any engineer wish to do so.

The arguments against the standardisation advanced in the editorial are, in the opinion of the Technical Committee, definitely unsound. First, although a few manufacturers are responsible for a large proportion of the total output of worm gears used in this country, there still remain a very large number of engineering firms who make worm gears for their own purposes. My Committee recognise the fact that many worm gears are designed on a hit-or-miss basis, and one of the main objects of the specification is to place within the reach of industry dependable information regarding efficiency, load-carrying capacity, necessary limits of accuracy, and so forth. While agreeing that interchangeability is never likely to be an important factor in worm gear and that it will not ordinarily be necessary to interchange worms and wheels made by different makers, yet interchangeability of the gears produced by any particular maker still remains essential, and this, in turn, makes desirable the adoption of a thread form which lends itself to ease of manufacture and measurement.

It is mentioned in the leading article that efficiencies of 98 per cent. are obtainable with worm gears. The Committee agrees and suggests that this leaves little room for further advance and affords presumptive evidence that some measure of standardisation is justified.

The Gearing Committee does not feel itself competent to deal with the issue raised in the last paragraph of the leader between the Institution of Mechanical Engineers and the B.S.I., but it feels that the Institution of Mechanical Engineers would hardly act so inconsistently as to afford the hospitality of their Institution, with the accompanying publicity to Dr. Merritt's paper on worm gearing, associated, as it is, with the forthcoming B.S. Specification for Worm Gearing, and, at the same time reduce their contribution in support of the B.S.I. because they felt that, in respect of worm gearing, the B.S.I. was going beyond its proper field of action.

R. DUMAS,
Chairman, Technical Committee M E/17,
Gears and Gearing,
British Standards Institution.

London, S.W.1, March 19th.

STRAIN ETCHING.

SIR,—I was very interested to read Professor I. F. Morrison's letter in your issue of March 15th. He remarks:

(i) "... wherever caustic embrittlement occurs, the metal in the immediate vicinity of the cracking shows the effects of overstrain"; and

(ii) "Such (overstrain) can be shown by Fry's etching process."

While the first statement will be readily accepted by all interested in failures in boiler practice, the Professor's second statement should be accepted with considerable reserve. It requires amplification for two reasons:

(*a*) A large number of mild steels used in boiler practice do not "strain-etch."

(*b*) For the satisfactory application of Fry's reagent, it is necessary to subject the test piece to a low-temperature annealing.

With regard to (*a*), Stromeyer[1] regarded nitrogen as one of the causes of embrittlement in boiler plate. Indeed, Fry's reagent was first used successfully on cold-worked steel of higher nitrogen content than is normally found. Such steels are almost always of basic origin. The majority of other types of mild steel used in boiler practice do not "strain-etch."

In the case of (*b*), while it is readily admitted that Fry's etching reagent[2] and its various modifications[3] are capable of showing overstrain, the state of the material adjacent to the area of overstrain shown by the reagent is a matter for conjecture. Rosenhain, commenting on the results of Jevons and Turner[4], considered the amount of heating (in the region of 200 deg. Cent.) demanded by this process as being just sufficient to remove some of the most characteristic mechanical effects of plastic deformation. According to Rosenhain, "If a piece of mild steel were strained beyond the yield point and examined afterwards, it would be found that it had a peculiar lack of elasticity; but if it were heated to 200 deg. Cent. for two minutes, that lack of elasticity disappeared and it appeared as a work-hardened steel having a reasonable elastic behaviour. ... Heating to 200 deg. Cent. caused recovery of elasticity and also brought about this property of etching."

That this effect cannot be disregarded was shown by W. R. D. Jones and the present writer[5] a few years ago. A test piece of high-grade mild steel plate was stressed in tension to failure. On one of the pieces Brinell indentations (1/30/30) were made, after polishing over the surface near the shoulders—so that definite differences in hardness should be obtained. After measurement the material was heated in the furnace for thirty minutes at 200 deg. Cent.—the method adopted by Fell[6]. It was found that the steel was not susceptible to strain-etching. The unused side of the specimen was then polished and hardness determinations carried out as before. A marked difference in Brinell values on both sides of the test piece was noted. The surface used prior to annealing varied between 130 and 165 Brinell, the majority being in the range 150–155. Corresponding values on the annealed surface showed Brinell hardness to be between 120 and 135. In consequence of these results, it is obvious that the annealing effect cannot be disregarded. Moser[7] claimed to have confirmed strain-etching results by Brinell determinations made on the various regions of flow (dark, light, and unetched) on steel stressed beyond the yield point. He did not show, however, that the hardness values which he had obtained would be the same if the annealing after straining had been omitted.

It has been stated that the Fry test is essentially qualitative[8]. The writer does not wish, in view of Moser's results, to contribute to that view, but he does feel that results obtained by the use of Fry's reagent should be accepted with reserve in studying caustic embrittlement in boiler plate—a phenomenon which has not yet been explained satisfactorily.

KENNETH G. LEWIS.

Cambridge, March 22nd.

STREAMLINING.

SIR,—May I venture to criticise your generally admirable leading article in last week's issue on "Streamlining" as to three points?

1. It tells us that the frontal resistance of a locomotive is of relatively small moment. In some circumstances, yes; but in a calm or head wind it is, I submit, not so. The conical doors, leaving a flat ring round the base of the cone, were worse than useless, but paraboloid forms, the full

[1] C. E. Stromeyer, Manch. Steam Users' Assoc. Mem., 1922, 14.
[2] A. Fry, Kruppsche Monatshefte, July, 1921, 117; B. Strauss and A. Fry, Ibid., 126.
[3] H. Meyer and W. Eicholz, Ver. deuts. Eisenhüttenleute, 1922, No. 20; G. Wazau, Zeits. des Vereines deuts., Ingenieure, 1924, LXVIII, 1185.
[4] T. H. Turner and J. D. Jevons, Cam. Schol. Mem., Iron and Steel Inst., 1925, I, 169; J. D. Jevons, Ibid., 191.
[5] W. R. D. Jones and K. G. Lewis, "Proc.," Inst. S. Wales Engrs., 1931, XLVII, 23.
[6] E. W. Fell, Cam. Schol. Mem., Iron and Steel Inst., 1927, 101.
[7] M. Moser, *Stahl und Eisen*, 1928, XLVIII, 1601.
[8] THE METALLURGIST, 1929, V, 132.

size of the smoke-box, which are used to some extent in France, and on the Great Western engine which has just been modified, are valuable during 80 or 90 per cent. of the time the engine is running at a high speed.

2. When speaking of a side wind, the old theory that flange friction is one of the chief causes of the great increase in resistance is brought forward again. In Chapter XII of my "Resistance of Express Trains," I proved mathematically, using Professor Dalby's methods, that it is a negligible factor. Slight lateral displacement of the train is even advantageous up to a point, producing steadier running and decreasing the impacts and friction at the windward rail.

But it is easy to show that the difference in the atmospheric conditions is ample to supply the cause of the drag, without leaving anything for surplus rail resistance. Take a simple case of a train travelling at V miles an hour, with a wind on the beam blowing at the same speed. The resultant of the two velocities is, of course, $\sqrt{2}$ V at 45 deg. to the rails. Relatively to the ground the train is going at V miles an hour in the direction of its length. But what is it doing with respect to the air? It is travelling through it nearly half as fast again, at an angle of 45 deg. to its longitudinal axis. Surely this is a true and sufficient explanation.

If the old theory is right and I am wrong, it would be found that on stretches of exposed line where the prevailing wind is from one side—there must be many examples—the lee rail would wear out more rapidly than the other one. But I think I am entitled, from what I have heard, to state that this is not the case.

3. The last part of the article, dealing with motor cars, contains a statement that streamlining is not worth while at speeds lower than 60 miles an hour. I should not have made any comment on this point if it were not for the fact that the same remark was made recently by one of the world's finest locomotive designers at the Institution of Locomotive Engineers, but applied to trains. In both cases it appears that speed over the ground was meant, the fact that air resistance depends on the relative air speed being left out of sight. This latter can, of course, attain a large value when the ground speed is but moderate.

I will conclude this letter by pointing out a difference in the conditions of a train and an air vehicle which is perhaps not generally realised and which renders "tails" to chimneys, &c. and to the last vehicle, less desirable than they might appear to be. On a train they are only of value when the wind is calm or dead ahead, and will have a bad effect when the resultant or relative wind is at all on the side. The section of an aeroplane strut is well known. Except when executing turns or "stunts," it is always going through the air in the line of its longer axis, because the machine has no lateral velocity relative to the wind, as it is borne bodily sideways with it. But a train makes no leeway whatever, so that when the wind comes at an angle to the rails the conditions are no longer the same.

C. F. DENDY MARSHALL.

Wonersh, March 23rd.

HIGH-SPEED TRAINS.

SIR,—The account and data published in your issue of the 15th inst. of the record railway run from Newcastle to London are very interesting, and great credit is reflected on the engineers responsible for the locomotive, especially as the speed obtained is probably beyond the range for which the component parts were designed.

On examination of the information given, it is evident that the engine was working with full regulator opening and 28 per cent. cut-off on the up gradient from Grantham, and that the steam supply was near the maximum, but after passing the highest point, and running down the gradient, it seems that the increasing difference between the boiler pressure and the steam chest pressure suggests that the regulator was not fully open, especially as the cut-off, after a short period at 22 per cent., was set at 27 to 32 per cent. Admittedly, you have stated that at 108 m.p.h. the regulator was fully open, but it would be interesting to know if the full steam was given to the engine for a few seconds in order to obtain the upward kink to this maximum figure in the speed curve.

As the valve travel on this class of engine is of what might be called medium length, the question arises whether the comparatively long cut-offs were made in order to give a long exhaust opening, in conjunction with partial regulator opening.

The question is prompted by a study of the high-speed run on the G.W.R. from Swindon to Paddington on June 6th, 1932, described in your issues for that month, when speeds of 91–92 m.p.h. were maintained with cut-offs of 17–18 per cent., with, I believe, a longer valve travel than that on the L.N.E.R. engine.

In both cases six coaches were hauled, but there was a difference in total train weights, that for the G.W.R. being 314 tons approximately.

P. W. BOLLEN.

Newcastle-on-Tyne, 2, March 25th.

SIR,—First of all, let me thank you very much for printing in your issue of February 1st my letter on the comfort of railway carriages, and also for your very excellent leader on the same subject in the subsequent issue. If one may judge from the construction programmes of the railways, which have since been published, they are taking our remarks to heart.

Under the heading "Rail and Road," in your issue of March 15th, I wonder whether you placed paragraph 8 and 9 adjacent to each other by design or happy accident. In paragraph 8 you will note that the chairman of the L.M.S. states that his view is "that high-speed trains, such as those driven by oil-electric engines," cannot be accommodated on the L.M.S. main line. In paragraph 9 the chairman of the L.N.E.R. is quoted as saying that his company was giving immediate consideration to the question of putting on a steam train to run to a similar schedule to that referred to on pages 270–271.

One of the advantages of the light-weight internal combustion driven engine is the close relation which maximum speed bears to average speed; that is to say, it would be quite possible to produce an oil engine-driven train which could equal the stop-to-stop times shown on page 271 without ever exceeding 85 m.p.h. On the very excellent run made by the "Papyrus" the speed had to be in the region of 100 m.p.h. and over for 10 miles, in order to secure the stop-to-stop average of nearly 70 m.p.h.

Surely it would be very much more difficult to find a "path" for the steam train than for the oil-electric trains. The very wide difference of opinion, therefore, between the chiefs of our two largest railways is even more marked than it would be if they had both been referring to the same form of motive power. RAILWAY TRAVELLER.

March 25th.

SIR,—The G.N. line from Corby to Peterborough has been for many years a favourite track for very high speeds.

From 1885 to 1890 I had to go every week from Yorkshire to London. The trains were drawn by the fine single engines, and did not stop between Grantham and London. The speeds were very variable, and as I had just acquired a stop watch, I regularly passed the time by taking the speeds. I was a good deal puzzled by the fact that speeds of 90 miles an hour were regularly recorded. These I repeatedly checked, and I found that my readings were quite correct.

The road was not good at the time, and we used to get some rough rides out. These big-wheeled single engines with light loads downhill were naturally able to go at very high speeds.

For many years I used these trains, but I never again recorded such high speeds, although the speed was more regular.

H. RAVENSHAW.

Grasmere, Westmorland, March 25th.

"UNEMPAYMENT" AND ENGINEERS.

SIR,—Last Thursday evening I had the privilege—I use the word advisedly—of being present at a meeting at the Central Hall, Westminster, to hear Mr. Gibson, a Sheffield chartered accountant, speak on Social Credit. When a speaker, without aid from the Press, but apparently merely by word passed from one person to another, can fill the Central Hall with the ordinary man in the street and his family, the subject must be close to the heart of the people. I was brought face to face with the fact that we engineers are either dangers to the community and worthy of "liquidation" or we are deserving of the greatest honours that can be bestowed upon us for ushering in a new age. Knowing full well the opinion held by the average chartered accountant concerning the creative engineer, it was refreshing to find that Mr. Gibson held the view that we deserved a crown, or shall we say a halo? There was also a subtle pleasure to be gained by hearing Mr. Gibson state that depression, poverty, &c., was, in point of fact, due to accountants generally having failed to appreciate a fundamental flaw in the world accountancy system. Above all things, it was gratifying to hear the admission from an accountant that the discoverer of the flaw and the remedy is an engineer. However, this is by the way.

The point I wish to make is that the engineering profession has been so far silent on the subject of this flaw, and its bearing on whether we revert to handicraft to provide employment for the people or realise that the inventive power of the engineers ushers in an age of leisure.

This year is particularly appropriate for consideration of this all-important subject by the engineering societies. It is the year of Jubilee, and if anyone cares to read the Mosaic Law they will find that certain things happened in the year of Jubilee.

Whatever we may think, the fact remains that the inventive power of the engineers is responsible for chronic unemployment, or, as Mr. Gibson preferred to call it "unempayment," until the obvious remedy is applied.

I feel that the world at large has a right to expect us to debate this question, and for the reason already stated 1935 seems to be a peculiarly appropriate year for us to do so through the medium of our engineering societies.

K. W. WILLANS.

London, W.C.2, March 23rd.

SIXTY YEARS AGO.

THE late Sir Charles Lyell, so we said in a memoir on his life and labours which we published in our issue of March 26th 1875, was far from being the creator of geology as popular ignorance had often fancied. Geology as a branch of study existed at the date of his birth, 1797, but it was still little more than a fragmentary chaos founded largely on scriptural myths or on barren and fallacious hypotheses. Those who studied it were divided into two hostile camps. In one it was believed that our globe was the result of the formative powers of water. The other pinned its faith to the action of fire. Lyell's mind was eminently judicial and comparative. It took the facts, or supposed facts, presented to it and sifted out the hypothetical imaginings by which the truth was obscured. More clearly than anyone before, Lyell saw that the key to all true geology lay in the doctrine that to explain the phenomena of the world we must appeal to Nature itself, that the forces now operative before our eyes are identical with the forces which, however long distant in the past, shaped the world to its present form. In his "Principles of Geology" published in three parts between 1830 and 1833 he laid the foundations on which geology subsequently lifted itself into a science. His early training was not such as to give him familiarity with the subject which he was eventually to make his own. In his father's house in Forfarshire he was instructed by a "dominie" as was still usual in those days in Scotland. At a later date he moved south with his father into Hampshire. In 1818 he entered Exeter College, Oxford where his career was undistinguished. After graduating he studied for the Bar to which he was called in 1824. He did little in that profession. In fact he disliked it and loved more to extract truths from Nature than the truth from witnesses. Within a year he was contributing to the Royal Society a paper on the geology of his native county and by 1830 he had begun his great work "The Principles of Geology." In 1832 he was appointed lecturer in geology at King's College, London, then newly founded. From then onwards until his death on February 22nd, 1875, he laboured strenuously in the interests of geological science. His views were of a boldness which we to-day can hardly appreciate. They did not go unopposed. As the head of the school of "uniformatists" he was opposed by Murchison the leader of the "catastrophists." Many, too, who believed in him for the most part felt that he was pushing his doctrine too far when he maintained that not only were the forces which had shaped the world in the past the same in nature but that they had also been the same in intensity or degree as those which still acted on the globe. His firm adherence to the belief announced by Playfair that the world presented no trace either of a beginning or of an ending also brought him many opponents. To-day these disputes have largely been resolved or have sunk into the background. Thanks to Lyell and those whom he inspired geology to-day has cast off speculation and is content to take the practical service of mankind's needs as its prime object.

Literature.

SHORT NOTICES.

Enquiry on National Public Works. London: G. Allen and Unwin, Ltd. Price 12s. net. 1935.—This volume is the result of a questionnaire sent out at the request of the Committee of Enquiry into Questions of Public Works and National Equipment, set up by the Communications and Transit Organisation of the League of Nations. The inquiry related to:—Public works undertaken in various countries since the beginning of 1929 (completed, in course of execution, or in preparation); the principal administrative methods followed for the execution of the work; the principal methods of financing; the allocation of expenditure on the execution of the works as between materials and equipment on the one hand, and labour on the other; the Governments' opinion with regard to the effects obtained or expected on the resumption of economic and industrial activities and on unemployment. Governments were asked to classify the work by categories as follows:—Roads and bridges; railways; agricultural land reclamation; canals and other inland waterways; land improvement work; provision of drinking water supplies and sewage disposal; work carried out in sea and river ports; establishment of airports; building work; electric installations; gasworks and gas supply; telegraph and telephone installation and wireless broadcasting stations; other work. The volume gives the answers of some twenty-nine Governments and the abundant material it contains will be found of much interest by the public authorities and engineers.

Government and Technology. By William Beard. New York: The Macmillan Company. 1934. Price 16s.—The title on the cover of this volume suggests that it is a monograph on national economics. It is, in fact, hardly that, but rather a treatise for United States students on American Laws as they affect technological enterprises. Yet the treatment is broad and the author has succeeded in making much of it interesting reading and in exhibiting the extent and ramifications of the American Government's contacts with or control of industries. He shows, too, in some cases, how this "interference," as the rigid individualist might call it, has arisen not by the initial wish of the State, but as the outcome of circumstances. The titles of a few of the eighteen chapters may give some idea of the nature of the contents. Here is a selection at random: "Popular Control in a Technological Society," "Judicial Processes of Law Enforcement," "Management of Government Expenditures," "Revenue-producing Enterprises of Government," "The Regulation of Public Utilities," "Patents, Copyright and Trade Marks," "Personal Liberty." Whilst the volume will not be of much material use to readers in this country, they will find it instructive as a guide to American practice. There are, moreover, many tendencies, if not actual acts, which are common to the governments of all nations. The presentation of them in this condensed form is a convenience.

BOOKS RECEIVED.

Laundries and Laundry Requisites, 1935. London: Shepherd and Hosking, Ltd., 24, Buckingham-street, W.C.2. Price 4s. 6d. net.

Electricity Law and Practice. By R. H. Studholme, M.A. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 30s. net.

Modern Surveying for Civil Engineers. By H. F. Birchal, O.B.E. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 25s. net.

Index to the Literature of Food Investigation. Vol. VI. No. 1, March, 1934. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price 5s. net.

Hydro-Electric Power Plant at Cardano.

No. I.

THE power plant at Cardano is situated in the Isarco Valley, at a short distance from Bolzano, on the Brenner Railway—see sketch map, Fig. 3. It is the most powerful hydro-electric power installation in Europe and offers a number of interesting features, which we propose to describe in some detail. The main characteristics of the plant are:—A storage basin of 63·8 million gallons capacity;

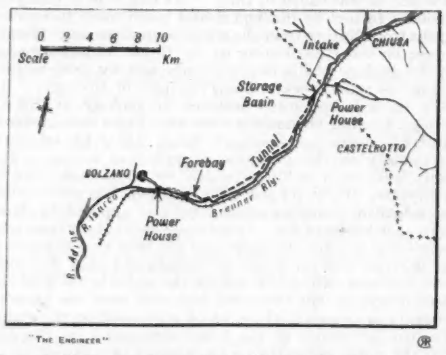


FIG. 3—SITE OF CARDANO POWER DEVELOPMENT SCHEME

a head-race in a tunnel, 9·05 miles long, which conveys water into a storage tunnel three-quarters of a mile long, opening into a forebay, and a pipe race of five pipes of 2800 mm. (9ft. 2½in.) diameter, and one pipe of 2000 mm. (6ft. 6¾in.) during the summer by molten snow and during the autumn by heavy rains. Exhaustive investigations have shown that the minimum flow of the river never falls below 25 cubic metres per second and that consequently the corresponding output of 250 million kWh per annum can be considered as continuously assured during the whole year. The useful annual average flow is 60 cubic metres per second. In the course of some 10 miles the river falls over 625ft.

At the upper level a weir of the usual type with three wide openings and one narrow (4 m.) is thrown across it to control the flow, as shown in Fig. 1. In front of the intake there is a diversion wall of concrete 24½in. high and 4 m. wide on the river bed, with an inclination towards the narrow sluice gate. When this gate is open the current is sufficient to convey the heavy gravel through it. Another wall prevents large floating pieces reaching the intake gates. In order to raise the level of the river during the winter months a second set of top gates, 90 cm. in height (35⅜in.), has been provided. They are lowered from the top and operated by the same machinery as the main gates. The large gates weigh 30 tons each and are counterbalanced by concrete beams. The intake consists of fifteen sluices, 9ft. 10in. by 4ft. 1½in. A special feature is a Dufour sand removal plant. Its construction was an absolute necessity in view of the fact that each cubic metre of water contains as much as 3 per cent. of sand and gravel. This would have meant that at high water as much as 5–15,000 cubic metres of sand and gravel would have settled in the storage basin in one day. The plant—easily distinguishable in Fig. 1, page 330—consists of five tanks, 11 m. wide and 25 m. long, each capable of dealing with 18 cubic metres per second. To

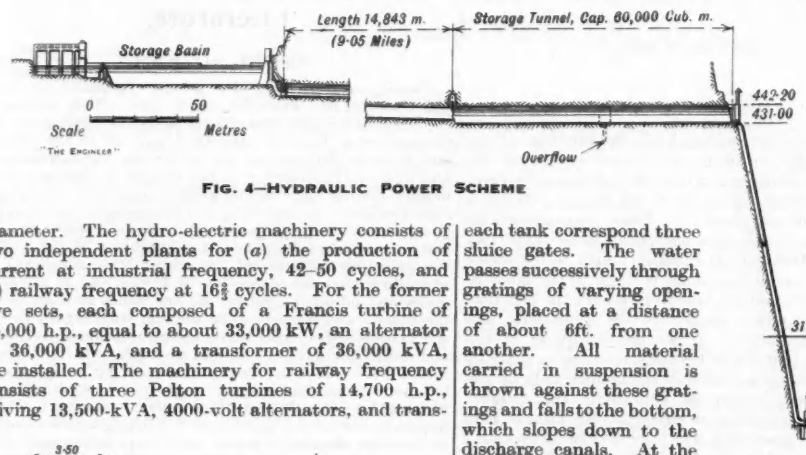


FIG. 4—HYDRAULIC POWER SCHEME

diameter. The hydro-electric machinery consists of two independent plants for (*a*) the production of current at industrial frequency, 42–50 cycles, and (*b*) railway frequency at 16⅔ cycles. For the former five sets, each composed of a Francis turbine of 45,000 h.p., equal to about 33,000 kW, an alternator of 36,000 kVA, and a transformer of 36,000 kVA, are installed. The machinery for railway frequency consists of three Pelton turbines of 14,700 h.p., driving 13,500-kVA, 4000-volt alternators, and trans-

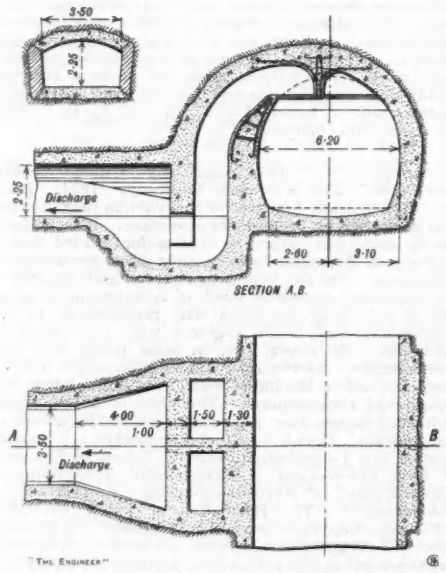


FIG. 5—GREGOTTI SYPHON

formers for raising the tension to 66,000 volts. For the station services there are two 500 h.p. Pelton sets.

A.—HYDRAULIC PART.

GENERAL REMARKS.

The power plant utilises the waters of the river Isarco, whose source is at a short distance from the Brenner Pass at the Austrian frontier. The Isarco is an affluent of the Adige and drains an area of 3350 square kilometres (1293·4 square miles), situated at an average altitude of 3300ft. above sea level. On both sides of the Brenner extends the massif of the Alps, with their snow-clad peaks and innumerable glaciers, from which, during the summer months, vast quantities of water descend. Thus the Isarco is fed each tank correspond three sluice gates. The water passes successively through gratings of varying openings, placed at a distance of about 6ft. from one another. All material carried in suspension is thrown against these gratings and falls to the bottom, which slopes down to the discharge canals. At the same time, the gratings have the effect of gradually decreasing the speed of the comparatively strong flow and rendering it uniform. The *débris* and gravel which are not retained settle in the tanks, on account of the reduced speed of the water, at the bottom and on the side walls. The latter are formed by steeply inclined convergent planes, on which the sand slides down and precipitates into a channel running in the centre parallel to the side walls. At the outlets of these canals gates are installed which allow the passage of a certain quantity of water carrying the settled material to discharge into a collector canal issuing into the overflow tunnel. Beyond the gates the purified water runs over a spillway into the storage basin.

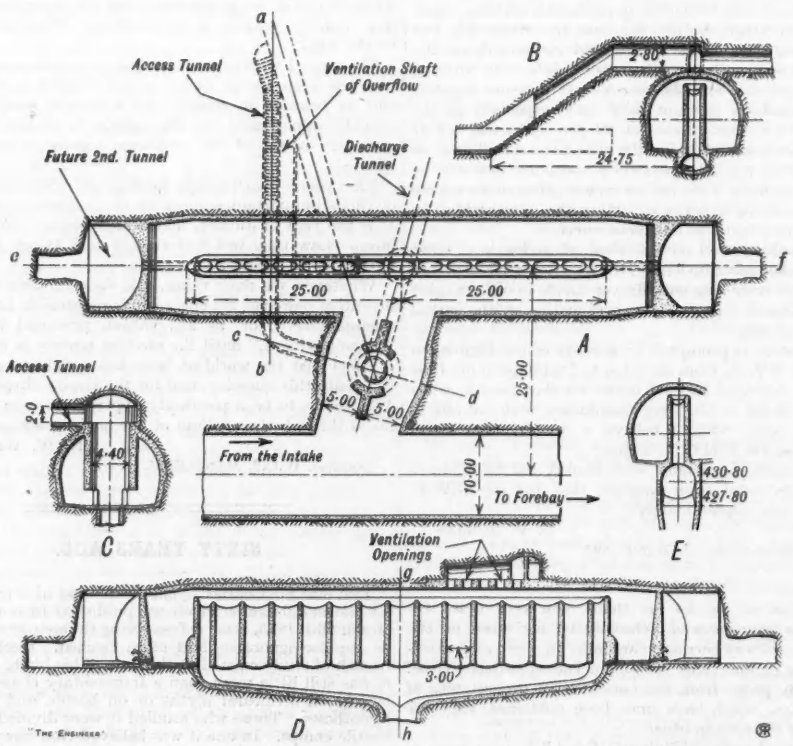
The Storage Basin.—This basin has a length of 420 m. and a maximum width of 85 m. The depth at high water is 7·50 m. For its construction 420,000 cubic metres had to be excavated. Its bed was constructed by covering the ground with a layer of gravel 40 cm. thick and sealing it with a layer of concrete 10 cm. deep and dividing it in sections of 4 m. by 4 m. The walls have an inclination of 45 deg. and are lined with concrete 30 cm. thick at the top and 50 cm. at the bottom. The mountain slopes above the concrete banks have been consolidated by retaining arches and pillars built into the ground—see Fig. 1. Acacia trees have been planted for further consolidation. In order to permit the cleaning of the storage basin without interfering with the service a by-pass canal connects the Dufour plant with the head-race tunnel.

The Head Race Tunnel.—The head race tunnel—see Fig. 4—consists of two sections, the head race proper, of a length of 14·843 m., and of the storage or forebay tunnel, of 1229 m. length. It has been built for a flow of 90 cubic metres per second; the inclination is 1 : 133; and the speed 3·1 m. per second.

The tunnel has a policentric section with an area of 31·4 square metres. It is lined with concrete, and faced with cement. The forebay tunnel has a clear section of 70 square metres. The construction of a second head race tunnel is projected. At present three short tracts of this second tunnel have been constructed at the beginning and the end of the forebay tunnel, and in correspondence with the overflow, to which reference will be made later.

At about 1000 m. from the head race gates two overflow syphons of the Gregotti type—Fig. 5—have been installed to prevent the whole tunnel being put under pressure in case of an excessive inflow of water. They discharge into the river.

About halfway along the forebay tunnel there is an overflow and automatic bottom outlet valve—Fig. 6. At this point about 330ft. of the second forebay tunnel—*e*, *f*, in Fig. 6—has already been constructed parallel to the first, at 25 m. centres, and the two are connected by a short chamber. The overflow is built in the second tunnel and consists of a concrete tank 50 m. long by 2·50 m. wide and 8 m. high. The inside of the tank is constructed so as to form fifteen wells having an oval cross section of 1·50 m. by 3·00 m. internal diameter. The wells have an outlet at the bottom leading into a collector canal, the bottom of which slopes towards the centre, where the waste water canal begins. This canal runs in tunnel at an inclination of 45 deg. and has a diameter of 3 m. It is lined at both extremities with riveted iron tubes 8 mm. thick, and the centre tract has a gunite cement lining 5 cm. thick. Towards the end it divides in two branches in a vertical sense—Fig. 7. The upper branch about 60 m. long continues on a slight down gradient and ter-



A—Plan of Overflow and Automatic Discharge Valve. *B—Section a.b. of Overflow and Access Tunnel.*
C—Cross Section c.d. of Discharge. *D—Longitudinal Section e.f.* *E—Cross Section g.h.*

FIG. 6—AUTOMATIC OVERFLOW AND OUTLET VALVE

minates through four vertical branch pipes leading into a chamber 30 m. by 5½ m. The lower branch continues at 45 deg. for a short length, and thereafter

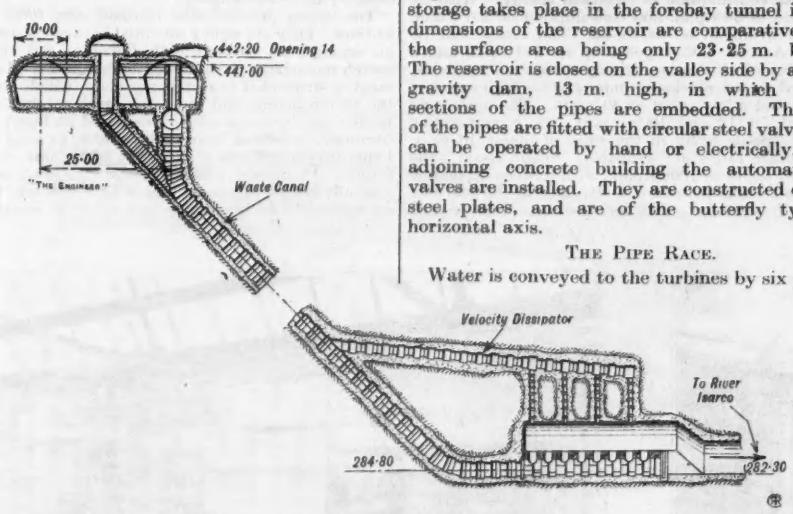


FIG. 7—VERTICAL SECTION OF WASTE CANAL

almost horizontally and discharges the waters through eight vertical branches in an upward direction into the same chamber. The water carried by these eight branch pipes is thrown vertically against the water issuing from the four pipes of the upper branch in the opposite direction. This opposing action considerably reduces the speed of the water masses which discharge over a spillway into the river. The length of the waste water canal is 400 m.

The automatic bottom outlet valve is installed in the traverse tunnelled chamber mentioned above. The valve itself is contained within a 4·4 m. circular masonry well, which pierces the crown of the tunnel and terminates in a chamber 3·50 m. high with a floor area of 42½ square metres. Here it communi-

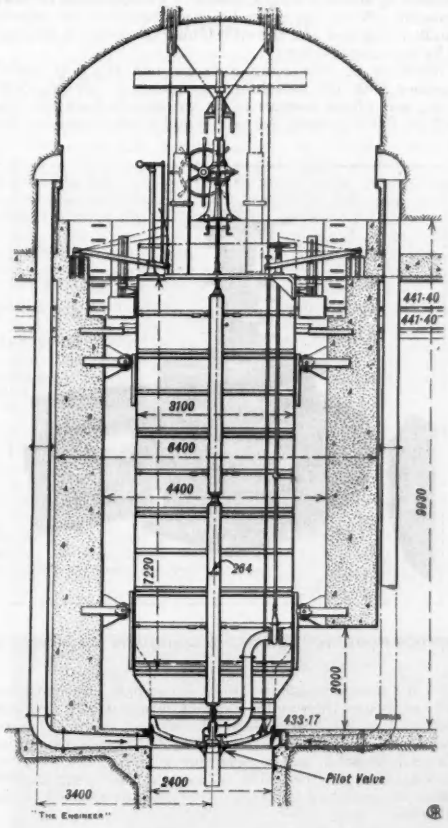


FIG. 8—AUTOMATIC VALVE

cates with the tunnel through two large lateral openings in its lower part through which the water discharges into the waste water canal.

The valve consists of an iron cylinder of the form shown in Fig. 8, the bottom resting on the valve seat. Water enters the cylinder through a pipe, which is always open. At the bottom of the cylinder there is a double-seated mushroom pilot valve. The cylinder remains on its seat when this pilot valve is closed, as in that condition, the cylinder being filled with water, its weight is superior to the reaction due to the different diameters.

By raising the pilot valve it closes the inlet pipe and opens a passage for the water contained in the cylinder. The cylinder empties, and once the water inside has reached a level which is sufficient to counterbalance the reaction, the cylinder rises from its seat. The pilot valve can be operated by hand or automatically.

THE FOREBAY RESERVOIR.

At the mouth of the forebay tunnel on the mountain slope, the forebay reservoir has been built, but as storage takes place in the forebay tunnel itself, the dimensions of the reservoir are comparatively small, the surface area being only 23·25 m. by 35 m. The reservoir is closed on the valley side by a concrete gravity dam, 13 m. high, in which the end sections of the pipes are embedded. The orifices of the pipes are fitted with circular steel valves, which can be operated by hand or electrically. In an adjoining concrete building the automatic relief valves are installed. They are constructed of welded steel plates, and are of the butterfly type with horizontal axis.

THE PIPE RACE.

Water is conveyed to the turbines by six pipe lines 330 m. long—see Figs. 2, p. 330, and 9. The pipe lines Nos. 1–5 have a diameter of 2800 mm., decreasing to 2500 mm. and to 1900 mm., and a static head of 160 m.

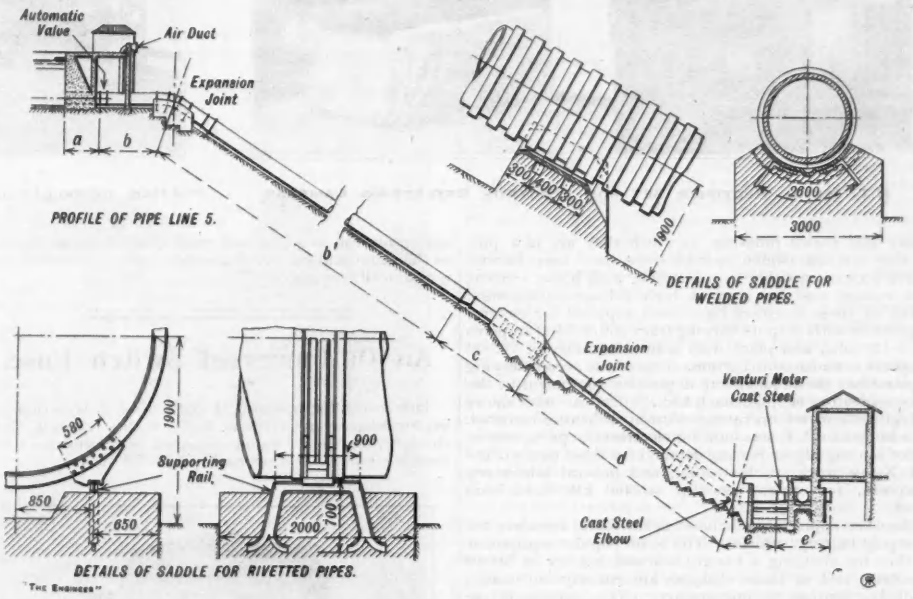


FIG. 9—PROFILE OF NO. 5 PIPE LINE

Each of these pipe lines feeds a group of 45,000 h.p. turbines. Pipe line No. 6 has a constant diameter of 2000 mm. and a static head of 158 m. It supplies a Pelton turbine for railway service, splitting at the end into three branches for three units producing three-phase current at 16⅔ cycles.

The pipes 1–5 are of riveted mild steel on the first section of about 200 m., *i.e.*, to the upper concrete anchorage. The remaining sections are of welded steel tubes reinforced by forged steel rings. It is believed that these tubes are the biggest hitherto constructed on this system. Venturi meters, Fig. 10, are fixed on each pipe line before their entrance into the power-house. Pipe line No. 6 is constructed throughout of riveted tubes. Venturi meters are placed on each of the three branches, which have a diameter of 1500 mm. before, and of 1003 mm. after the Venturi meter.

The concrete piers supporting the pipe lines are built into the rock, and are spaced 9 m. apart. Those supporting pipe lines 1–5 are saddle shaped, and the pipes rest on curved steel sheets—see Fig. 9.

The pipes run parallel at a distance of 4 m. from one another as far as the lower anchorage. Thence, 1 to 5 continue fanlike and reach the bottom anchorage at 10 m. centres.

Expansion joints are provided immediately after the upper bend and after the upper anchorage. On their last section the pipes are rigidly embedded in the lower anchorage and in the foundations of the power-house.

The average speed in pipes 1–5 is, at the normal water *régime*, 4 m. per second, and in pipe 6, 5·7 m. per second.

The tail-race has a length of 600 m., and runs first in the open, and thereafter in tunnel. Near the junction with the river there are two electrically operated gates and a pumping installation of 1320 gallons per second capacity for keeping the tunnel clear in the event of inspection or repairs of the

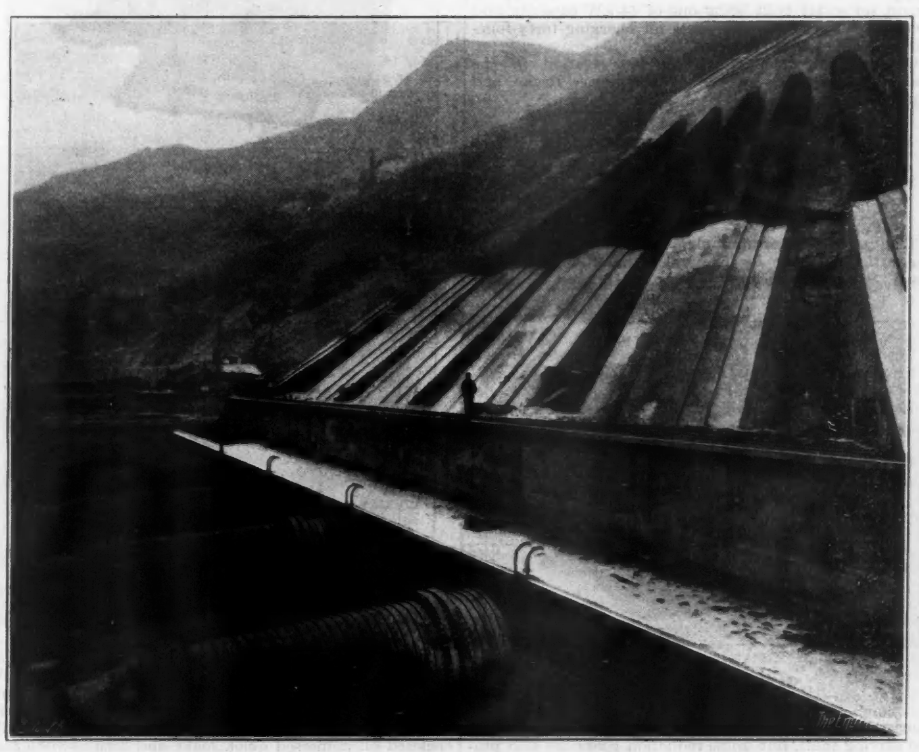


FIG. 10—VIEW OF PIPES ENTERING POWER-HOUSE, SHOWING VENTURI METERS

turbine outlets. The tail-race will be utilised as the head race for a new power plant, and the two gates will then separate the tail-race from the river, so that the new head race will be the direct continuation of the tail-race.

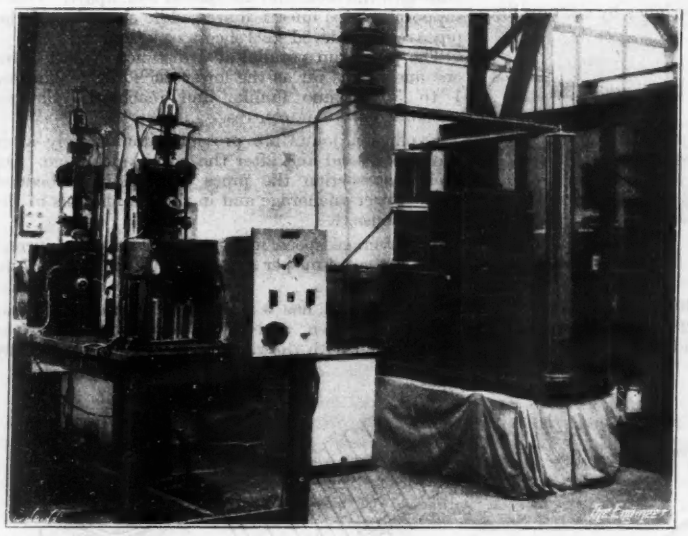
(To be continued.)

New Applications of Metal Rectifiers.

PROBABLY few imagined, when metal rectifiers were first introduced, that they would ever be employed for the many and varied purposes to which they are now put. During the last twelve months there have been further developments, notably in connection with heavy current low voltage and low current high voltage equipments. Many of these rectifiers have been supplied for electro-deposition with outputs varying from 500 to 3500 ampères at 6–12 volts, and plant with a total capacity of 29,000 ampères is under construction. One of the accompanying illustrations shows an electro-deposition equipment at the wireless factory of McMichael, Ltd., whilst the other shows a high-tension set operating electron deflecting cameras. In addition to H.T. sets built for electrostatic precipitation there is a rapidly increasing demand for these equipments for X-ray work, cable testing, and general laboratory purposes, for which sets up to 400 kW have been built.

Another appreciable demand is for metal rectifiers for charging battery vehicles. The most popular equipment is that for charging a twenty-four-cell battery at 20–10 ampères, and as these chargers are entirely automatic, skilled attention is unnecessary. The vehicle driver merely inserts a three-pin plug into a socket, and when the battery is fully charged the current is switched off by contacts on the ampère-hour meter on the vehicle. Normally the charge has a natural taper from 20 to 10 ampères, but an equalising switch is provided for giving a half charge during the week-end. Chargers of this type are made singly or in units for three, six, and twelve vehicles, the largest set so far built being one of 44 kW capacity and consisting of six two-circuit sets for charging forty-four-cell batteries at 40–20 ampères.

Other applications are under investigation in the research department of the Westinghouse Brake and Signal Company, 82, York-road, King's Cross.

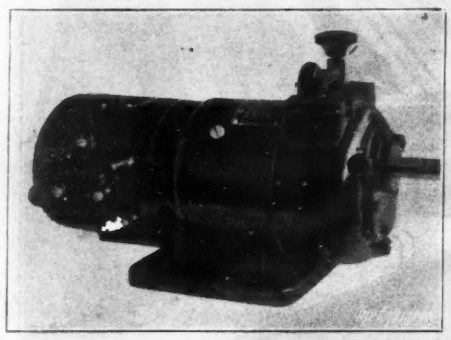


H.T. METAL RECTIFIER SET FOR ELECTRON DEFLECTING CAMERAS

PLATING INSTALLATION OF METAL RECTIFIERS AT A WIRELESS FACTORY

Geared Motor Units.

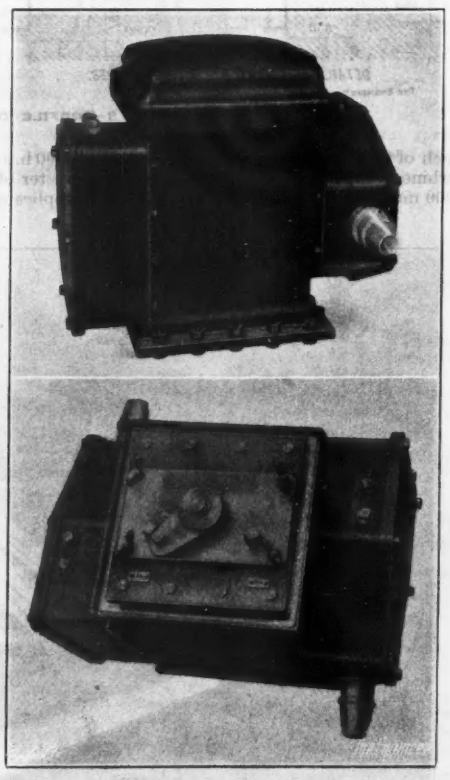
THE geared motor unit shown in the accompanying illustration is made by Kiaxon, Ltd., of 36, Blanford-street, W.1. It consists of a ½ h.p. electric motor with a spur reduction gear for giving two alternative speeds on the driving shaft, but single reduction gears are also provided when required, or gears which raise the speed of a 50-cycle, 2580 r.p.m. motor up to 6000 r.p.m. or more. The primary object of the design is to provide a unit capable of giving a high torque at a relatively low speed with a small consumption of electrical energy. With an output speed of 30 r.p.m. and consumption of 350 watts, the torque available is 400 lb.-in. The motor can be wound for A.C. or D.C. supplies up to 500 volts, and a large number of alternative driving speeds are available. A unit used on a centreless grinder gives a high speed of 320 r.p.m. and a low speed of 30 r.p.m. The unit could be supplied for 12 and 1000 r.p.m., the corresponding alternative speeds being in the ratio of about 10 to 1, although other ratios are available. Single speed units are supplied for 12 to 1000 r.p.m., with torques depending on the speed. Like the motor shaft, those of the gear-box run in ball bearings. The nickel-chrome heat-treated steel gears run in an oil bath with splash lubrication, and as the input and output shafts are fitted with seals there is practically no loss of oil.



GEARED MOTOR UNIT

An Oil-Immersed Switch Fuse.

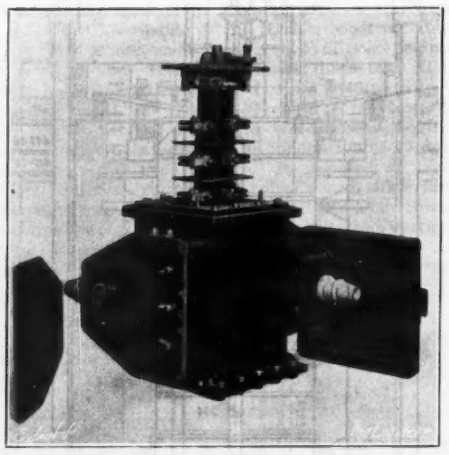
THE search for economical methods of distribution has led Switchgear and Cowans, Ltd., of Old Trafford, Manchester, to introduce an oil-immersed switch fuse for high-tension circuits. It is primarily intended for use under the pavements or roadways of busy towns, in which space is valuable and the opening up of the surfaces of busy thoroughfares must as far as possible be avoided. The dimensions have been reduced to the lowest limits consistent with reliability, and a diving bell cover prevents water finding its way into the unit in the event of the chamber in which it is installed being flooded. The totally enclosed oil immersed quick make and break switch fuse is accessible from the top without moving the oil tank or running off the oil. It is designed for use on circuits up to 3300 and 11,000 volts, each size being made for single, two, or three-phase supplies and having a current carrying capacity up to 100 ampères.



OIL-IMMERSED SWITCH FUSE

The spring jaw movable contacts also form the fuse carriers. They are rigidly mounted between phase barriers on strong rods covered with Bakelite, and the rotary switch movement gives a long double break. The equipment is suspended from the top plate, which also carries the switch handle and the quick break mechanism. The blade type fixed contacts are mounted on heavy Bakelite terminals moulded into cast flanges forming oil-tight joints between the tank and cable boxes, into which they project. Composed of fabricated welded steel, the tank is carefully tested to ensure that it is completely free from oil leakage. As the diving bell cover is maintained in position by its own weight, it can be quickly lifted off and replaced. When the cover has been removed the switch handle is exposed and the switch may be operated directly or by an extension key.

Removal of four wing nuts permits the top plate, together with the switch mechanism, fuse carriers, contacts, and phase barriers to be withdrawn from the oil, and the fixed contacts are visible and accessible under the oil. An interlock ensures that the switch fuse must be fully off before the moving element can be withdrawn and that it must be lowered into the correct position before the switch fuse can be re-closed. Although the illustrations show a switch fuse for underground service, modifications of the cable boxes and operating handle make it suitable for use in other situations outdoor or otherwise.

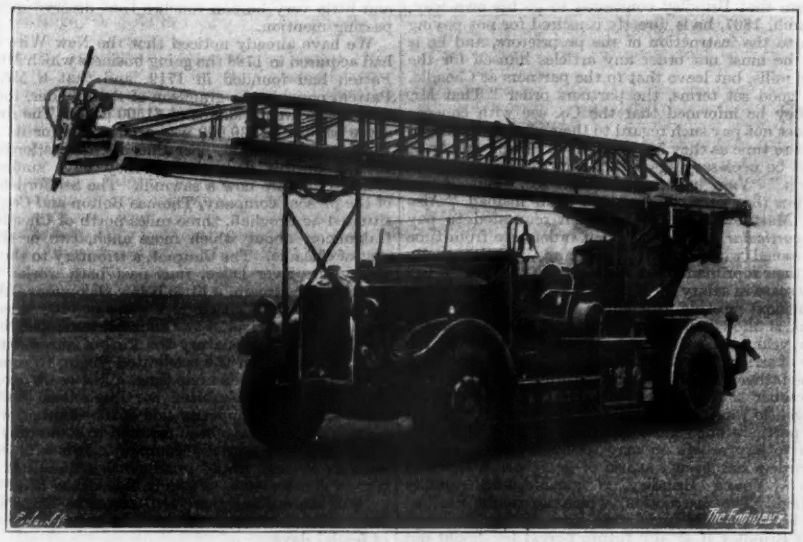


SWITCH FUSE WITH SWITCH MECHANISM WITHDRAWN

70ft. Motor Turntable Ladder.

THE motor turntable fire ladder illustrated has just been completed for the Wimbledon Fire Brigade by Merryweather and Sons, Ltd., of Greenwich-road, London, S.E.10. The ladder, which is designed to reach a height of 70ft., is entirely of steel, similar to but lighter than those supplied by the firm to various other places in this country and abroad. It is in three sections and the turntable is arranged to rotate the ladders round a complete circle. All movements—elevation, extension, and rotation—are carried out by power from the four-cylinder 82 b.h.p. petrol engine, which propels the Merryweather-Albion chassis on which the ladder is mounted. Three hand levers control the gears for the movements, all of which may be in operation at the same time, if desired, while a pedal conveniently placed for use by the operator governs the speed. For adjustment while a fireman is at the top of the ladder there is a special slow-speed gear. A patented automatic safety control governs the extension and lower-

ing of the ladders at safety margin, and automatic stops prevent the ladders being over-extended. An indicator shows the operator the amount of the extension of the ladders and a graduated quadrant the angle of elevation. This quadrant also shows the safe extension at any angle.



70 FT. MOTOR TURNTABLE LADDERS

At the head of the top ladder there is a water tower consisting of a double swivelling monitor nozzle with a hand lever for directing the jet. There is a hinged platform for the operator and a life line with 80ft. of cable. Loud-speaker telephone apparatus keeps the man at the top in touch with the turntable platform operator. The very full equipment includes a double-sided hook ladder and a 35ft. extension ladder.

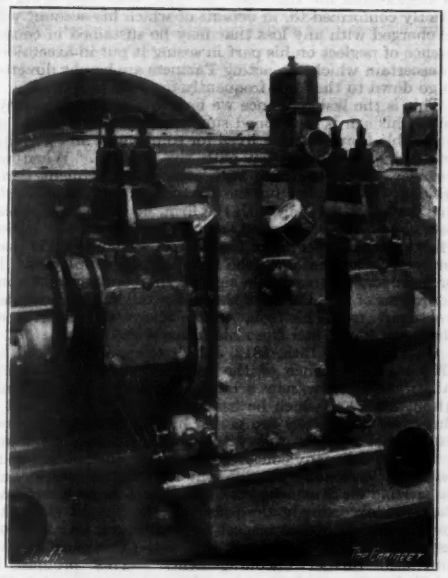
Refrigerating Plant on M.V. New Zealand Star.

IN an article published in our issue of December 29th, 1933, we described a 160 b.h.p., four-cylinder, *vis-a-vis* oil engine, designed by Mr. H. V. Senior, of the Brush Electrical Engineering Company, Ltd., of Loughborough. In the accompanying engravings we show two views taken at Falcon Works, Loughborough, of a larger engine, having a maximum output of 340 b.h.p. at 375 r.p.m. This engine has been adopted for driving CO_2 compressors on three ships of the Blue Star Line, Ltd., designed for the trade between this country and New Zealand and Australia. Each ship carries two refrigerating units, and two ships, the "Imperial Star" and the "New Zealand Star," have been completed and are on service. The third ship, the "Australian Star," is now nearing completion. Of the six CO_2 compressor units, four have been supplied by J. and E. Hall, Ltd., of Dartford, and two by the Liverpool Refrigerating Company, Ltd., of Liverpool.

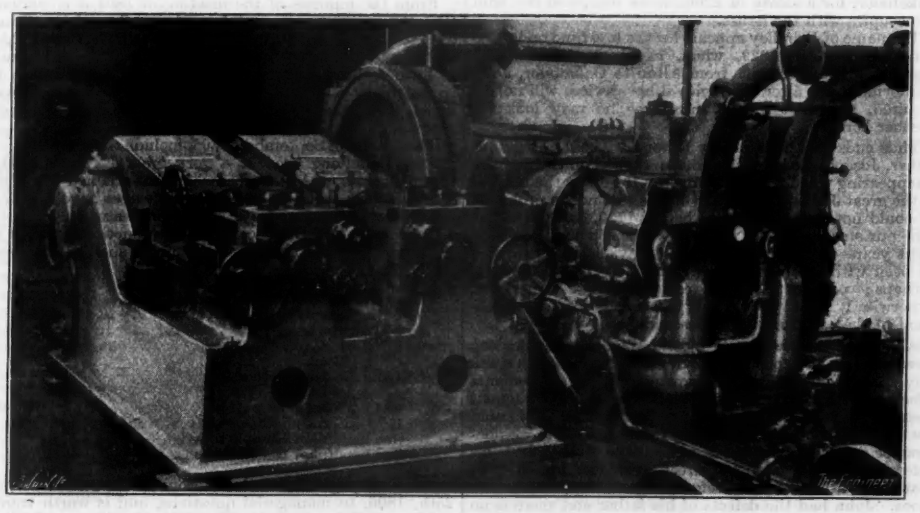
The illustrations we reproduce show the Brush-Hall machinery for the "New Zealand Star," which vessel left London recently on her maiden voyage.

The designed speed of the oil engines has been specially slowed down to suit the piston speed of the CO_2 compressors, and a rated output of 250 b.h.p. at 250 r.p.m. has been adopted. This gives the engine a wide margin of power. We recently inspected the plant, and were impressed by the very compact arrangement which allows it to be accommodated in a small space, with headroom of only 6ft. to 8ft., without sacrificing full accessibility to every part of the machinery. A new feature of the design is the fitting of the exhaust valve on the top, and the inlet at the bottom of the breech end. With the air valve at the bottom, which is the coolest part of the breech end, a maximum air charge is obtained, and the spray valve is also cooler. Again, should any dribbling take place, the drops of oil cannot fall on the hot exhaust valve, but are carried forward by the stream of incoming air, and, form a combustible mixture, with the next charge. It is possible to change the exhaust valve, sprayer, and air valve while the engine is running. This being so, any damage to the perishable cargo which might be caused by a possible stoppage of the refrigerating plant is rendered very remote.

We have referred to the wide margin of power available, and the wide range of speed over which the engine can be economically run. One engraving shows the arrangement of the governor and fuel pump controls at the side of the engine. There are two governors and a simple change-over device. One governor controls the speed of the engine from the slowest speed of about 65 r.p.m. up to, say, 150 r.p.m., while the second governor controls the range between 150 and 250 r.p.m.. There are two control levers, one for starting and stopping and the other for regulating the advance and retard of the fuel injection period. During our recent visit to the ship, the engines started easily, ran quietly, and responded quickly to the controls.



GOVERNOR AND FUEL PUMP CONTROLS



HORIZONTAL VIS-A-VIS OIL ENGINE AND COMPRESSOR

We understand that the recent acceptance tests were very successful, and that an average fuel consumption of 0·38 lb. of fuel per b.h.p.-hour was attained, which will most likely be further improved upon after the engines have been running some time. These good trial results have, we are informed, been confirmed by the results at sea. We may also place on record that the Brush Electrical Engineering Company, Ltd., has now received a repeat order for six further engines for driving CO_2 compressors for marine installations.

Iron and Steel Institute.

THE annual meeting of the Iron and Steel Institute will be held on Wednesday to Friday, May 1st to 3rd, 1935. The meetings will be held in the Institution of Civil Engineers, Great George-street, Westminster. The morning sessions will open at 10 a.m. and the afternoon sessions at 2.30 p.m. On Wednesday the annual general meeting will be held, and the President, Sir Harold Carpenter, will present the Bessemer Gold Medal to Professor A. M. Portevin, and then give his Presidential Address. The following papers will be discussed:—"Third Report of the Corrosion Committee," being a report of a Joint Committee of the Iron and Steel Institute and the British Iron and Steel Federation to the Iron and Steel Industrial Research Council; and, should time permit, "Further Determinations of the External Heat Loss of Blast-furnaces" (Carnegie Research Paper), by Mr. D. F. Marshall. The following papers will be discussed at the afternoon session:—"An Effect of Oxygen and Sulphur on Iron in Scaling," by Mr. J. H. Whiteley; "An Investigation of Spring Steels," by Messrs. J. H. Andrew and G. T. Richardson; "The Deflection of the Rolls in Plate, Sheet and Strip Mills," by Mr. J. Selwyn Caswell; "The Iodine Method for the Determination of Oxides in Steel," by Messrs. T. E. Rooney and A. G. Stapleton; "An Investigation into the Oxidising Power of Basic Slags," by Messrs. J. White, R. Graham, and R. Hay.

The following papers will be taken as read, and written correspondence is invited:—"Resistance of Spring Steels to Repeated Impact Tests," by Messrs. G. A. Hankins and H. R. Mills; "Non-Metallic Inclusions in Ferro-Alloys," by Mr. B. Matuscheka. Communications have been received as follows:—"A Note on Reproducible Sulphur Prints," by Mr. W. H. Dearden; and "Electro-Chemical Interpretations of 'Cleaning,'" by Messrs. E. Jimeno and T. Grifoll.

On Thursday and Friday there will be a Symposium on the Welding of Iron and Steel. The presentation of the Groups and Sub-groups will be as follows:—

Thursday: Morning session.—"Present-day Practice and Problems of Welding in the Engineering Industries: Bridge and Structural Engineering, Pressure Vessels, Railway Material and Shipbuilding." Afternoon session.—"Present-day Practice and Problems of Welding in the Engineering Industries: Aeronautical, Automobile, Chain, and Electrical Industries, Iron and Steel Castings, and Wrought Iron." Friday: Morning session.—"Welding Practice and Technique and Welding Apparatus." Afternoon session.—"Specification, Inspection, Testing, and Safety Aspects of Welding." Over 130 papers will be considered at the Symposium.

The following social functions have been arranged:—On Wednesday evening a conversazione will be held at the Science Museum, S.W.7, from 8 p.m. to 11 p.m. On Thursday, the annual dinner will be held in the Grand Hall, Connaught Rooms, Great Queen-street, W.C.2, at 7 for 7.30 p.m. On Friday evening at Grosvenor House, Park-lane, W.1, there will be a dance from 9.30 p.m. to 2 a.m.

INSTITUTION OF NAVAL ARCHITECTS.

THE annual meetings of the Institution of Naval Architects will be held in the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, W.C.2, on Wednesday, Thursday, and Friday, April 10th, 11th, and 12th. The annual dinner of the Institution will be held on Wednesday, April 10th, at 7.30 p.m., in the Grand Hall of the Connaught Rooms.

On Wednesday, April 10th, there will be a meeting in the morning at 10.30 o'clock, at which, after the transaction of the usual business, the President, the Right Hon. Lord Stonehaven, will deliver his address. The following papers will then be read and discussed:—"Launch of the Quadruple-screw Turbine Steamer 'Queen Mary,'" by Mr. J. M. McNeill; "Transport of Refrigerated Cargoes under Modern Marine Practice," by Mr. A. R. T. Woods.

On Thursday morning, April 11th, the meetings will be resumed at 10.30 o'clock, when the following papers will be taken:—"Channel Train Ferry Steamers for the Southern Railway," by Sir Westcott S. Abell; "Resistance Experiments in Smooth and Rough Water made with Models of High-speed Ships," by Mr. J. L. Kent and Mr. R. S. Cutland; "A Simplified Form of Direct Flooding Calculations," by Mr. J. L. Scott.

At the afternoon session at 2.30 the following two papers will be considered:—"Steamships with Main Boilers on Deck," by Mr. K. G. Meldahl; and "The Evolution of the Modern Steam Trawler with Superheating," by Mr. W. H. C. Nicholas.

For Friday morning, April 12th, at 10.30 a.m. the following two papers have been arranged:—"The Corrosion Problems of the Naval Architect," by Dr. W. H. Hatfield; and "An Experimental Investigation of Cracking in Mild Steel Plates and Welded Seams," by Professor E. G. Coker, F.R.S., and Professor B. P. Haigh. There will be an afternoon session at 2.30, at which the following two papers are to be taken:—"A Standard of Stability for Ships," by Professor E. Pierrottet; and "Ship Wave Resistance: Progress since 1930," by Mr. W. C. S. Wigley.

The Order Book of the New Wire Company, Cheadle, 1788-1831.*

By L. ST. L. PENDRED.

AMONGST the historical documents of the English brass and copper industry, the order book of the New Wire Company of Cheadle,† in Staffordshire, is well known. There are many references to it in H. Hamilton's "The English Brass and Copper Industries to 1800" (Longmans, 1926); but it is believed that no complete survey of its contents has hitherto been given. As, in many respects, it may be regarded as a document of exceptional human interest, and as, moreover, it shows the industries of the so-called industrial revolution in a more favourable light than some historians have shed upon them, it is thought that an account of its contents is worthy of attention. The book, a small vellum-covered quarto, is now the property of Thomas Bolton and Sons, who acquired the property of the Cheadle Brass and Copper Company in 1852, and has been very kindly lent to the present author by Mr. E. J. Bolton, to whom and to Captain H. C. Anstey, of the company, the author desires to express his thanks not only for the loan, but for other help rendered in the preparation of these notes.

The volume opens at the year 1788, by which time the company had already been in existence for nearly seventy years, having been founded in 1719 by Thomas Patten. The first minute, dated August 5th, 1788, informs us that "the late partnership under this Firm having been dissolved on the 29th March last," seven gentlemen have agreed to take up the twenty shares between them. The largest shareholder was Mr. Thomas Patten, who took twelve at £1500 apiece. The dividend was fixed at 5 per cent. per annum. The last entry is dated July 1st, 1831. The volume therefore covers a period of forty-three years in one of the most interesting epochs of British industry, including the ambit of the Napoleonic wars and the industrial disturbances which they caused.

THE BRINDLEYS.

In a footnote to his *Life* of James Brindley, the famous mechanical and civil engineer, Smiles mentions that we find James's father "in 1729 purchasing an undivided share of a small estate at Lowe Hill within a mile of Leek in Staffordshire." Now Leek lies about 10 miles north of Cheadle, and when we come across the familiar name of Brindley at the works of the New Wire Company, it is not unnatural to seek for a connection with the great man. James, himself, was born near Macclesfield in 1719–1720, and his history is well known. He was the eldest child and inherited his father's small property on which he lived for some years. But he did not marry till he was fifty-one, and died a few years later, leaving two daughters; there is just a chance that the Brindleys of Cheadle were descended from one of his brothers.

These Brindleys—Joseph, his son Matthew, and the latter's son, John—appear frequently in the Order Book. The partners showed them great, and in some cases peculiar, consideration, as will be seen. The first entry, August 5th, 1788, informs us that Matthew is "to be allowed in future a Sallary of £60 per annum as a Reward for his attention, &c.," and that Jospeh is to be invited "to accept £20 a Year for Life or during the Co's pleasure." Apparently Joseph was an old man as age went then, for on August 3rd, 1790, we find his name occurring again in juxtaposition with an order that "all the old disabled Workmen at Alton Mills be discharged when they are incapable of wire drawing, and that £5 be given to each man upon his discharge as a Reward for his services if he deserves it." Joseph is to be pensioned off with an annuity of £20. But it was not so easy to get rid of him. His discharge should have taken place in August, 1789, yet a year later we learn that it "is postponed on Accnt. of his ill state of Health." In August, 1791, another Brindley, this time with the significant name of James, is appointed clerk to the company at a salary of £35 per annum. In the following year Matthew receives a gift of 20 guineas "for his attention to the late Improvements at Alton Mills and O'moor." O'moor is Oakamoor, about which we shall hear more. In 1793, Matthew gets another present, £10 this time, "as a reward for his ingenuity in making the machine to cut Brass plates."

The regular August meetings of the company were not held in 1794 and 1795, but in November of the latter year the partners agree to pay Matthew's rent, amounting to £12 10s., on "Several small pieces of ground near Alton Mills" as a "further compensation to him for his Care and Industry in the Companies Affairs under his management." Two years later he receives 50 guineas "as a mark of approbation from the Company of their sense of his indefatigable Zeal and Attention to their interest." In 1800, £20 are given to him "as a reward for his ingenuity in the improvement of drawing thick wire." In 1803 there is an interesting entry: "That the allowance to Matthew Brindley for Ale and Entertainments to the Co. and their Servants be advanced to £30 per annum from March 26th last, as his former one of £15 a year for that purpose it is thought has been inadequate."

On November 19th, 1804, Matthew's position was still further improved, for he is directed to superintend the mills at Oakamoor, for which he is to be allowed, in addition to his salary, the sum paid to the late James Kent, but is to employ constantly at his own expense a person "to take account of the different transactions in that concern."

So far Matthew Brindley had walked on a primrose path. He had been frequently commended by the partners; had received numerous and substantial marks of their approval, and had been given more and more responsibility. But in 1804–5 things had not gone so well. It is clear from the entries of September, 1805, that there had been some trouble in the works, three men were dismissed, and strict orders which indicate the existence of financial slackness were issued. Amongst them we read: "That Matthew Brindley be requested to give a Bond to the Co. for £400 and pay the balance of his Account to the end of the present Month both at Alton and Oakamoor, and no balance to appear against him hereafter." Furthermore, it is ordered "That Oakamoor Mills be paid more attention to by the Agent,—Matthew—or the Person appointed by the Agent, and that the Orders issued from time to time by Mr. Ingleby with respect to both Mills be strictly observed."

Despite these hints of the partners' displeasure, it would seem that Brindley continued to go his own way, for in March, 1807, he is directly censured for not paying attention to the instruction of the proprietors, and he is told that he must not order any articles himself for the use of the mills, but leave that to the partners at Cheadle. Then, in good set terms, the partners order "That Mr. M. Brindley be informed that the Co. see with concern that he does not pay such regard to their resolutions issued from time to time as they have a right to expect, and trust it will not be necessary again for them to advert to such inattention." Vain hope, as we shall see. But having written thus they crossed it out and wrote instead, "Also that Mr. Matthew Brindley be again requested to pay *the most particular attention* to what orders are from time to time issued with regard to the Mills," and actually softened their reprimand with a douceur in the form of £40 a year increase in salary!

At their next meeting, November 16th, 1807, Brindley's son, John, is offered the agency of O'moor, with a salary of £80 a year and a house, but again they stress the necessity of strict observance of their orders, thus perhaps giving the father a left-handed blow through the son.

On October 25th, 1808, Matthew Brindley receives another gentle reprimand. He had again been negligent and the partners once more entreat him "to pay strict attention to any orders he may receive . . . as a neglect of such orders has been a cause of great dis-satisfaction to them." Young Brindley is much more roundly admonished. The instruction, which no doubt reached his ears, is "That Mr. Ingleby do immediately discharge Mr. John Brindley if at any future period he should not do the duty required of him as an Agent to the Company."

On March 31st, 1810, young Brindley is again reprimanded. He is told roundly that a more active personal part is required, and that unless he attends to "the Duty chalked out to him" at Oakamoor "he may consider himself at liberty to provide a new Situation."

In August, 1811, owing to further trouble at Alton, Mr. Brindley "is hereby informed that he will be considered as responsible for the time to come that this order is strictly conformed to, in default of which his account will be charged with any loss that may be sustained in consequence of neglect on his part in seeing it put in execution, to ascertain which the acting Partners are hereby directed to go down to the Mills frequently for such purpose."

This is the last reference we find to the elder Brindley, but as his son is mentioned subsequently as "Junior," it is possible that Matthew lived for some years and perhaps retained some connection with the concern. When we consider the forbearance with which his frequent derelictions were treated by the partners we must conclude that he had been long with the firm, no doubt before the new company was formed, and that, like an old butler whose present defects are forgiven in memory of his past services, he still retained the respect of his employers. It is, however, a remarkable sign of the courtesy and consideration of the Partners that they put up with similar treatment from his son, upon whom the mantle of obstinacy had fallen from his father's shoulders.

On September 15th, 1812, John's salary is advanced by £100 in consequence of the increase of business which falls upon him by new arrangements at Oakamoor and Alton, &c., "of which he has the general management." But even whilst they are giving him this, for the period, substantial increase of pay they wish him to understand "that the Company conceive he is very deficient in superintending *personally* the different Men at both works and *in exerting the Authority over them which he possesses*, and they are exceedingly desirous that he should act with greater energy in this respect for the future, an attention to which hint may, perhaps, induce the Company to give him still further encouragement." This promise is fulfilled two years later, when John is given another £30 a year.

Several years pass before we hear of Brindley again. A period of great depression had been encountered, and salaries had been reduced temporarily, but on October 28th, 1823, it is resolved that "Mr. John Brindley Junr's salary is advanced by £100 owing to his general steadiness and good conduct." Five years later we read that Mr. Wragge (one of the partners) agrees to become manager at Oakamoor, for a salary of £200, house rent, and the land he occupies with the house.

The name of Brindley appears for the last time under the date August 5th, 1829, when, in consequence of the removal of the wire mills from Alton to Oakamoor, John is informed that after the removal his services will not be required, and that in the meantime he may look for another berth.

Thus ends this little family history. About the grandfather, Joseph, we learn but little; he was on the point of disappearing when the annals open. If he was the brother of the great James Brindley, which is just not improbable, he could not have been born before 1720, so that at the time our story opens he might have been a man of sixty-eight years—a great age for those days. How long had he been with Thomas Patten and Co.? Over fifty years perhaps; perhaps less, but certainly for a long time. Otherwise it would be difficult to account for the attachment of the company to his descendants.

About Matthew we know most. Whatever his defects, he appears to have been a man of character and, in a small way, an inventor. He is commended for improvements effected in the machinery of the mills, and despite frequent scoldings is constantly advanced in position. That could not have been from old standing friendship alone. Somehow or other his qualities must have outweighed his defects. We are without direct evidence, but suspect that he was an old man before his son stepped into his shoes. John had the defects of his father and there is no record that leads us to believe he had equal merits. It is true that in the end he was commended for diligence, but the readiness with which the Partners got rid of him when he was still young enough to look for other service, and the fact that there is no mention of a pension, or even a parting testimonial, seems to indicate that, on the whole, he was not a very profitable servant. His chief call upon our notice is that he may have rounded off the century of service of one family to one concern.

ALTON AND OAKAMOOR.

Grateful as we are to the Order Book of the New Wire Company for this minor epic of the Brindleys, we find in it also interesting scraps of contemporary industrial history, and little very human touches that deserve more than a passing mention.

We have already noticed that the New Wire Company had acquired in 1788 the going business which Mr. Thomas Patten had founded in 1719, and that a Mr. Thomas Patten, possibly the grandson of the founder, took twelve out of the twenty shares of £1500 each. The firm with a share capital of £30,000 was a large one for its day. Its works were at Alton, near Cheadle, in Staffordshire, and remain to this day, though they have suffered many changes and are now a sawmill. The Staffordshire works of the present company, Thomas Bolton and Co., Ltd., are situated at Froghall, three miles north of Cheadle, and at Oakamoor, about which more anon, two or three miles east of Cheadle. The Churnet, a tributary to the beautiful Derbyshire river Dove, runs past both works. Alton is on the same stream, a little below Oakamoor. A Norman castle, built by Richard de Verdun in 1100, once frowned upon the little river, but Cromwell destroyed it. In the middle of the last century the Earl of Shrewsbury rebuilt it to the designs of the celebrated Pugin, to represent the original structure. At one time, a few years ago, a colony of French nuns inhabited it. Pugin also built "Alton Towers,"* on the opposite side of the Churnet, whose once famous gardens have been restored to something like their old spendour by a private company. It is with this district with its element of old romance that our little industrial history is associated. From it, it takes on itself a touch of ancient charm, and there still seems to linger round the old works at Alton and Oakamoor some of the best spirit of feudal days.

At the Alton Mills copper was refined and brass wire was drawn, and one of the first works of the new company was the erection of four more brass ingot furnaces which Thomas Salt was to work. At that date we read that "Charles Carr shall have the Melting House he now works in to himself and as a further Reward for his Industry in the Co.'s Interest" he shall be given five guineas. In a minute of 1790 we find the first reference to Oakamoor Mill. It is to "be employed at present in the Tin Trade and not to be altered for making Wire." In the same year two or three more apprentices were taken on at Alton. They were over fifteen years of age, were bound for seven years, and were trained in the "art of Wire drawers." The decision about Oakamoor did not hold, for only a few months later, the partners "express the opinion that the Mill shall be altered to Roll and Slit Brass and Copper and to draw thick Wire and Guinea Rods,"† the tin business being carried on as usual. A new ingot house was ordered to be built at Spout, a farm recently purchased from Sir Joseph Banks.

For several years the company appears to have suffered from trade depression and no dividends were paid. Nevertheless, faithful servants were not forgotten and we read of several gratuities, some of which, as already seen, fell to Matthew Brindley. In 1797, James Barton is to be paid "Twelve pound per annum for the saving made and to be made by his invention of a substitute for Tallow."

From a note of 1798 we learn that the company paid 5s. 6d. per ton of 22 cwt. for coal and that calamine cost £6 2s. 6d. per ton. The partners were still disturbed by the industrial conditions and in order to keep their men in employment instructed Mr. Dagley and Mr. Brindley to discuss the best mode of making iron wire. This Mr. Dagley appears to have succeeded the late Mr. Rupert Leigh as treasurer, and a year later is given £50 for unravelling Mr. Leigh's confused accounts.

In 1800 we hear of Mr. John Vivian being admitted a partner in the copper-smelting concern of the company, which was carried on at Penclawdd, in South Wales. A workman named Joseph Finney is given 3 guineas for inventing a machine to point thick wire, no doubt to enable it to enter the drawing dies.

In August, 1802, old Thomas Patten, whose signature has been getting more and more shaky, signs the minutes for the last time. At the annual meeting in 1803 several interesting entries were made. The partners desire to know "if other Copper Works allow the same Ale to the men as at Penclawdd Works," and they give orders that a wall is to be built from copper slags round the Brass Works to stop the "Pilferage of coals."

From the minutes of the meeting of 1804 it is evident that the company was not in a strong financial position despite the fact that it had a capital of £106,421 5s. 2d., and no debts, for it had to borrow £10,000 upon bond. A little technical note is of interest: "Copper shot is to be made perfectly dry and sifted thro: a fine sieve, which sieve shall be made of copper with holes punched through about the size of Meal Sieves."

The entries of September, 1805, include the following:—"The Co. having been at a very great Expense in the improvements at Alton Mills which has enabled the Wire Drawers very much to increase their wages have this day resolved and ordered (as a small compensation for such improvement and Expence) That no reduction be made in the prices, but that the sizes and Bundles shall be increased in weight and weigh as under:—

5 Band and 4 Band Rings to be same weight as usual.	
1 Ring 3 Band to weigh	36 lb.
1 „ 2 „ „ „	37 lb.
1 „ 1 „ „ „	38 lb.
1 „ Thick „ „	38 lb.
1 Bundle 5th hole to weigh	74 lb.
1 „ 4th hole „ „	76 lb.
1 „ 3rd hole „ „	78 lb.
1 „ 2nd hole „ „	80 lb.
One handful of Rumple to weigh	41 lb.
and One handful of Rolled Brass	42 lb."

A whole page of the Order Book is devoted on April 25th, 1806, to managerial questions, and is worth transcribing: "That three Months Notice be given to Benjm. Keys, Benjm. Keys Junr. and Michael Keys, that the Co. from their late conduct, cannot after that period employ them in their service; but in the meantime will continue

* Newcomen Society for the Study of the History of Engineering and Technology.

† See Appendix.

* Visited by the Society in 1932, "Trans.," XII, 121.

† See Appendix.

to allow them Coals and House Rent, and at the expiration of the three Months, they are expected to quit the Premises of the Company at the Brass Works, and provide themselves elsewhere."

"That the Yard Men at the Brass Works continue at their Work till 4 O'clock on a Saturday, from the end of the present Month."

"That no Money be paid in future to John Wardle for Overwork."

"That no Ale be allowed in future to the Men at Alton for Slitting etc., but that if it be found necessary some allowance in money be made in lieu of it, and that, till further Orders, the Men slit only in working Hours."

"That 1/6th part be deducted the present Month, and till further orders, from the Amount of Chas. Smith's wages."

"That Oakamoor Mills be paid more attention to by the Agent, or the Person appointed by the Agent, and that the Orders issued from time to time by Mr. Ingleby with respect to both Mills be strictly observed."

"That the Amount charged to the Co. for Eating and Ale at Oakamoor for Mr. Jno. Brindley be deducted from the Agency, the Co. not chusing to allow it."

A note on September 22nd, 1806, refers to the purchase of land near Oakamoor "for the purpose of raising the head of water and consequently adding to the power of the Mills."

In November, 1807, the company decides to enter into the tin trade again, and orders the necessary alterations to be made at Oakamoor. In the following year, Mr. Brindley is asked to see if too much water is being wasted at the Oakamoor Mill, and approval is given for the construction of a dam at Alton.

On March 31st, 1810, we learn that "very general complaints (which the Co. views with great regret and indignation) have been made that the wire is irregularly drawn." Orders are given, therefore, that the "rings" are to be opened and gauged from time to time, and that notice of "the Marks attached to any of the rings that may be very deficient are to be sent to the office so that the Drawer or Drawers may be known." M. Brindley is directed "to take particular notice that no Rings be sent from Alton Mills without such marks and that any Person or Persons hereafter found guilty of irregularly drawing thin wire or putting Midling or Short Strings in the Rings, be immediately discharged and *never on any account be again* taken into the Company's service." This notice was to be stuck up in the Annealing Room at Alton Mills.

Then we have a curious entry:—"That Benjamin Keys and his Son be given to understand that the Company do not consider that they can do justice to them as *Melters* if they continue to carry on their trade as *Maltsters* conceiving that it must in some measure interfere with the time they ought entirely to devote to their interests; they therefore must expect that they either give up their Malting Business at the end of the present Season, or leave their present Service of which they have their choice."

On this date the company decided to give up its farming and corn milling, and an order was made "that no future allowance of Hay or Grass for the keeping of a Cow be made to any of the Co's servants, they having the greatest reason to suppose that such privileges have been grossly abused."

The question of the Copper Works is again minuted, and, finally, under this date, we have this entry: "That in consideration of the Partners being entertained at their Meetings at Mr. Ingleby's House (instead of at an Inn as heretofore) the Company grant an annual allowance of Fifty pounds for that purpose." As the average attendance at the meetings of the partners, as recorded in this book, was about six, and as they met only once or twice a year, this allowance would seem to indicate that the "entertainment" was on a very generous scale.

On December 11th, 1810, we find this rather characteristic entry: "That the sum of £10 per annum be given to John Keates as a compensation for his having hitherto been allowed the keep of a Cow etc. which the Co. can no longer grant having given up their team and set their land."

It would appear that the trouble at Alton was not easily settled, for in a minute of 1811 we read: "That the Wire Drawers at Alton do absolutely draw their Wire in future according to the increased Weights as settled so long since by the Company and so often repeated to Mr. Brindley who is hereby informed that he will be considered as responsible for the time to come that this order is strictly conformed to, in default of which his account will be charged with any loss that may be sustained in consequence of neglect on his part in seeing it put in execution, to ascertain which the Acting Partners are hereby directed to go down to the Mills frequently for such purpose."

An entry of a very different kind occurs on September 25th, 1817. It runs: "It having been suggested that Mr. Wilson and Mr. Watkins be requested to sit for their Pictures at the Expense of the Company to be hung up in the House of Business of the Company at Cheadle and they having obligingly consented thereto, Ordered that Mr. Keeling be employed on this occasion and that he wait upon those Gentlemen for the purpose as early as may suit their convenience." Mr. John Watkin's name figures in the first page of the Order Book—August 5th, 1788, and Mr. Thos. Wilson signs the book for the first time in 1800.

A year later we read that Mr. William Keates having devoted his leisure hours to chemistry with a view to the benefit of the concern is awarded 10 guineas. Two years later Mr. Ingleby is authorised to send Mr. Keates to London for a few months "for the purpose of studying Chymistry at the Expence of the Company." Surely this must be one of the earliest examples of a works chemist being educated by a manufacturing concern.

Here is another interesting entry: "This concern having been established 100 years on the 29th September 1819, Resolved that the Centenary be celebrated by giving a Dinner on that Day to the Friends and Principal Connexions of the Company as well as to their Workmen and that the next Annual Meeting of the Compy. be fixed for Monday, the 27th September 1819 in order that the Partners may the more conveniently attend the Dinner." The invitations were to be sent out in this form:—

"Sir,

The favour of your Company is requested by Messrs. Thomas Patten & Co. at Dinner on the 29th Inst. (at the Royal Oak Inn) to celebrate the Centenary of their Establishment.

N.B. Dinner on the Table at 3 o'clock."

Unfortunately, we are never told how the Centenary Dinner went off.

On September 27th, 1819, the company decides, owing to "an extreme depression in Trade and very great opposition in the market" by Birmingham wire drawers who sell very low owing to their establishment expenses being "very trifling," "to do away with the Establishment at Cheadle which they conceive is not essential to the concern." This intention was not carried out, but from a later entry it appears that the wire mills were removed from Alton to Oakamoor.

In 1822 the firm seems to have taken up a new and profitable line of business. It purchased Mr. Hollingdrake's patent for pressing copper rollers and decided, if the roller business went on well, to buy a steam engine of 6 h.p. for about £250 to turn the lathes at Oakamoor "by which means the Company would be enabled to extend their business very considerably." Mr. William Daniels is given £30 "for the great attention he has paid in the casting of the Patent Copper Rollers," and Mr. Joseph Finney is to be allowed one shilling on each roller sold. From a later entry we learn that the rollers are used for calico printing machines, for Mr. Ingleby, in Manchester, is allowed £100 per annum for entertaining British and foreign printers.

In September, 1828, it is ordered: "That no time be lost in building a Wire Mill at Oakamoor and bringing up the machinery from Alton Mills, the Company being determined to remove thence with all convenient speed."

In 1830 no dividend is paid and strict economy is enforced, and in 1831 the dividend is £150 instead of £250. Trade is still very depressed and salaries are again reduced.

The intention to get out of Cheadle—the head offices of the concern—is revived, and the last entry in the little volume runs: "That the Company remove their office of Business to Oakamoor as soon as it can be arranged, when Mr. Milner will be allowed a Pony, and the expence of keep, to enable him to attend there with as little inconvenience as possible."

APPENDIX.

The author is indebted to Mr. Rhys Jenkins for the following notes which serve to elucidate passages in the paper:—

W. Pitt, "History of Staffordshire," 1817.

"There are extensive brass and copper works, belonging to Messrs. Patten and Co., situated in a valley on the Tean, about half a mile south of Cheadle. Part of the copper is supplied from a mine at Mixon, but the principal part is brought from the great mine at Ecton. The copper and brass are smelted in the furnaces here. The brass is made into ingots for the brass-founders, and copper and brass are rolled into sheets."

Lardner's "Cabinet Cyclopædia," 1834, "Manufactures in Metal," III, 185.

"Cheadle, in Staffordshire, has long been noted for producing a fine yellow brass, particularly in the article of wire, or in large sheets, 3 or 4 feet in length, and from 2 to 3 feet wide. These large sheets are rolled from plates cast between two smooth granite tables; the undermost one having a raised margin of iron to confine the metal and determine the thickness of the plate, in a way similar to that practised at Stolberg [near Aix-la-Chapelle, described on page 183 of the same book].

"In Birmingham the brass intended for rolling is run into cast iron moulds, the ingot weighing from 20 to 30 pounds; and as this is frequently but little extended in width during the laminating process, the sheet when thin is often upwards of 20 yards in length; it is neatly rolled up in the manner of a riband and tied with wire for the convenience of carriage. A great deal of the Birmingham sheet brass, being composed of shruff or old metal, with other economical ingredients, is very inferior in colour and ductility to that from Cheadle: it is, however, much cheaper than the latter, and will stand the fire better in soldering."

"Birmingham and the Midland Hardward District, 1866," page 319. Article by W. C. Aitken on "Brass and Brass Manufacture."

"A considerable quantity of the brass wire made in Birmingham finds its way to the Gold Coast, to Old Calabar, in the form of what are called 'guinea rods,' one hundred of which, each three feet in length, of Nos. 4 and 5 gauge in thickness, packed up in deal cases, and being at their destination sold in exchange for palm oil, etc., are used as the 'circulating medium' by the natives, and at the death of the possessor are interred with the body."

"'Ripping' or 'rumpling' was the term for the first drawing operation, and in the early days it was performed by an intermittently-operating apparatus; I am inclined to think that the term comes from a still earlier process in which the strips were actually ripped apart—but this is only a notion. The term 'rumple' I do not remember to have come across. 'Bands' I should have thought were still an article of commerce. I remember, as a boy, being familiar with coils of yellow metal strip which might well be called 'bands.' The expressions '3 band,' '2 band,' etc., I suppose were some indication of thickness or width."

Houghton, "Letters on Husbandry, etc.," July 2nd, 1697, referring to brass wire manufacture at Esher, says:—

"They also finish 80 rings a week, each containing one quarter of a hundred."

"At Oakamoor over the doorway of a lofty building which I took to be a tin house, there is a stone with the inscription 'R.L. & Co. 1792.' I have not found out what the initials signify."

Patent, James Hollingrake, of Manchester [4287], 7th August, 1818:

"Manufacturing copper or other metal rollers for calico printing." The method was to compress the fluid metal in an iron mould till it solidified.

Power Plant for Automatic Telephone Exchanges.*

PRIOR to the introduction of the common battery system of telephone switching, electrical energy for telephonic communication was largely derived from primary batteries situated at the subscriber's premises and at the exchange. The advent of lamp signalling and the subsequent concentration of power supply for all purposes at the exchange (first introduced into this country in the year 1900) was a most important advance in telephone switching, and opened the way for the comprehensive development of power plant for telephone exchanges. The introduction of automatic switching which quickly followed still further increased the demand for electrical energy, and the supply of power became a question of still greater significance. The consumption of electrical energy in Post Office telephone exchanges in the United Kingdom and Northern Ireland has been estimated now to be in excess of 20,000,000 units per annum, a load of no little importance to engineers engaged in the generation of electrical energy. The extension of power supply into rural districts, which is now proceeding rapidly (to some extent as a result of the provision of the grid), and the development of small petrol-driven power units, have made possible the utilisation of electrical energy for telephone purposes to an extent hitherto impracticable, and greatly assisted the introduction of automatic telephone service into remote country districts, with which rapid strides have been made during the past few years. The telephone engineer now has to deal with all classes of power plant ranging from that of the small eight- or ten-line rural exchange to those with a current consumption of approximately 20,000 ampère-hours per day. Perhaps it may be of interest to mention that the capital cost of the entire power plant of a telephone exchange now approximates to 10 per cent. of the total cost of the telephone exchange equipment, and for a large exchange may amount to as much as £10,000.

The function of the power plant in a modern telephone exchange is to furnish electrical energy at the appropriate voltage for the following purposes:—(*a*) Energisation of operator's and subscriber's transmitters; (*b*) subscriber's and exchange signalling; (*c*) provision of tones, &c.; (*d*) operation of switching mechanisms (there may be approximately 16,000 switches and 65,000 relays in a fully equipped 10,000-line exchange); (*e*) sundry purposes, *e.g.*, alarms and emergency lighting.

The design of power plant must therefore be determined with due regard to the switching requirements, the standardisation of which may be followed by standardisation of the associated power plant.

The power plant may be regarded as the heart of a telephone exchange, as withdrawal of electrical energy from the apparatus will immediately deprive the exchange of the ability to perform its allotted functions.

The usual source of supply is the local generating station. Continuity of supply is of paramount importance, and hence the provision of reliable standby precautions, for use in the event of failures, is essential. Alternative sources of main supply, secondary batteries, and prime movers, are examples of customary standby provisions. The use of secondary batteries is now practically universal, and adequate means of maintaining the batteries in a suitably charged condition under all circumstances are provided.

Three principal methods of supplying power to exchange equipment have been adopted for large exchanges—(*a*) "charge-discharge"; (*b*) "assisted-discharge"; and (*c*) "floating"—the system to be employed depending upon the telephone administration and to some extent on local conditions. In this country large exchanges are worked almost entirely on a charge-discharge basis, although assisted-discharge is now being adopted. Floating systems are extensively used in America.

The conversion of the energy derived from supply mains to the appropriate D.C. voltage is generally accomplished by means of motor generators. The type of machine employed depends to a certain extent upon the supply system. When the machine is floated on the battery, an electrically quiet machine is essential, and mechanical quietness is desirable in order to avoid acoustic interference. The importance of electrical quietness is not so great when the "charge-discharge" method is adopted, and in this case commercial type generators are usually employed. Automatic voltage regulation is employed in conjunction with float systems.

The overall current consumption is not steady throughout the day, but varies with the exchange calling rate. Hence the current consumption of an exchange depends upon the busy-hour calling rate, which naturally coincides with the maximum load. Some of the largest storage batteries in use are employed for telephone exchanges, and special considerations are necessary in their design. A fully equipped 13,000-ampère-hour cell weighs over 3 tons. Lead-lined wood containers are used in place of the glass containers of the smaller cells, on account of the difficulty experienced in forming glass to the required size. The construction of the positive and negative plates is not identical, owing to the different properties of the active material, but the largest possible surface area for the active material, compatible with plate strength and shape, is arranged for.

Owing to the excessive weight, special attention must be paid to floor construction. Initial care in the assembly of the cells and provision of floor supports ensures freedom

* Abstract of paper read by Mr. K. B. Baldwin before the Students' Section of the Institution of Electrical Engineers.

from trouble during service. The connections between positive plates of one cell and negative plates of the next are of two types—(*a*) bolted connections and (*b*) autogenous lead burnt connections. The lead burnt connection appears to be preferable because of its more uniform ohmic resistance. Room ventilation is of importance on account of the emission of gas which occurs during charging. Several methods for overcoming the disadvantages which accompany this gassing have been tried, but so far with little success.

The power board forms the main link between the charge and discharge feeders and serves to accommodate the instruments required for indicating the current and voltage values at various points of the power supply. Machine circuit breakers, when employed, are mounted on the power board, and a section is allotted to ringing, machine control, and tone observation.

Fuses and switches provided upon the battery control panel rank in current-carrying capacity with those of commercial power plants, although the telephone voltage and total energy demands are lower.

The power system is protected by a system of graded fusing arranged so that as far as possible local circuit faults do not cause interruptions to the power supply or to other circuits. There are in general three types of fuses in use—(*a*) main fuses or circuit breakers; (*b*) suite fuses; (*c*) individual circuit fuses.

Voltage drop and current-carrying capacity are the chief considerations governing the design of power distribution feeders. The British Post Office specify a voltage drop of 1 volt between the batteries and the switch racks, and careful calculations must therefore be made in order to determine the requisite cross section of the conductor. In general this consideration outweighs the current-carrying capacity of the conductors, and it may usually be assumed that if the feeders allow an overall voltage drop of not more than 1 volt, they will satisfactorily carry the maximum current.

Nevertheless, the current consumption of apparatus supported by the various racks must be considered in relation to the dimensions of rack and suite distribution feeders. This calculation differs from that made in determining the battery capacity in that the maximum consumption of the racks, rather than the overall circuit drain, must be dealt with. Also the drain varies for positive and negative feeds according to the class of circuit accommodated by the racks.

Main discharge feeders supply the current from the power board switching points to a convenient point in the apparatus room, where transverse feeders are connected to convey current to the suite feeders, which run at right angles.

Rack discharge feeders connect with the suite feeders and discharge current to the individual circuits through alarm type fuses. The feeder fuse panels accommodating the feeder fuses are connected between the suite and rack feeders.

In addition to the main power plant described, a telephone exchange includes auxiliary apparatus, such as ringing machines, booster batteries, rack lighting, &c., with which the power engineer must also contend. Ringing machines are primarily used for furnishing ringing current, but perform subsidiary functions in the supply of tones. Each large exchange is provided with a ringer driven from the normal supply and another as a standby driven by the exchange battery. Tone induction generators are used for some exchanges abroad, instead of the high-speed drum machine described. These devices eliminate the necessity for brush gear, and both the exciting and stator windings are stationary. The tone inductor consists of several stators mounted in one case with a D.C. exciting system and a rotor with the requisite number of teeth to give the desired frequency. Special precautions are taken in the distribution of tone leads to prevent interference with talking circuits, a possible source of trouble in telephone work which must be guarded against.

The success of, and advantages derived from, automatic voltage regulation indicate that in the near future more extensive use of automatic operation of power plants as at present successfully applied in small exchanges is likely to be introduced. The extended use of better filter arrangements is likely to render unnecessary the special construction of the telephone generator and permit the more general use of ordinary commercial machines. The adoption of "float" schemes will probably become general, and a considerable reduction in cost of telephone power plant may be anticipated.

The development of telephone power plant of an elaborate nature since the inception of the central battery system has already been referred to. Further general increase in the use of the telephone which may be confidently anticipated in this country and the further applications of automatic appliances will undoubtedly lead to still greater power consumptions. The introduction of improvements and economical measures now under consideration by many administrations will no doubt lead to more efficient operation and secure further economies.

Aluminium Machining and Forging.*

ALTHOUGH pure aluminium may be machined satisfactorily if care be taken in the choice of tool, the majority of parts which have to be machined are made in one of the light alloys, which, as a class, are harder and easier to machine than the pure metal.

The machining speed of all light alloys may be high, a feature greatly in their favour, as it has a considerable effect upon machining costs. The economy in this direction, in conjunction with the saving in weight, is such that the final cost of an aluminium alloy part may be less than that of a similar one in cast iron, despite the higher cost of the light alloy on a weight basis.

Turning.—While it is impossible to give directions which are applicable to all light alloys there are some general points which are common to all.

The tool should always be finished with the keenest possible edge, and any grindstone marks should be removed by an oilstone. The top surface of the tool should offer as little resistance as possible to the turnings, and should be ground to a very smooth finish.

It should have a front clearance of about 10 deg., a top rake ranging from 40 deg. for softer alloys to 30 deg. for harder ones and a cutting edge angle of 35 deg. to 50 deg. Provided that the work is of a rigid nature, as much as $\frac{1}{2}$in. to $\frac{5}{8}$in. sometimes may be taken off in one roughing cut when running at a speed of from 500ft. to 700ft. per minute. A lubricant should be used for heavy cutting of this nature, although lighter roughing cuts often are done dry. A speed of 600ft. to 800 ft. per minute may be used for finishing cuts when using ordinary carbon steel tools. With tools of high-speed steel, the speed may be even higher. The attainment of a good surface depends upon a very light cut and a slow feed. A lubricant always should be used for finishing cuts, and a mixture of paraffin oil and lard oil, or rape oil, in equal proportions gives good results with most aluminium alloys.

The lubricant should be used under pressure, and should be so fed that it tends to clear away the turnings from the work.

It is important to remember that the coefficient of expansion of light aluminium alloys is high, and that it is essential that the work be cooled before finishing to accurate dimensions.

Screw-cutting and Tapping.—Screw threads may be cut in the usual way, first with a single pointed tool and then with a hand chaser for finishing. For good work it is essential to use a liberal amount of lubricant. Paraffin oil is recommended.

Fluted taps are preferable for tapping holes in aluminium, but with care, it is possible to obtain good results with ordinary taps, provided that the initial hole is of the correct diameter. The best diameter is found by trial. With soft aluminium, such as aluminium plates, the hole should be larger than with harder aluminium castings, for example, because the tap has a pressing effect in addition to the cutting action, and allowance must be made for this.

For tapping, bees-wax or tallow is used for lubrication.

In repetition work, threads sometimes are formed by a process known as "thread rolling." Hardened rolls having threads cut upon them are pressed into the aluminium, raising a corresponding thread by squeezing the metal. This process can be applied to screws up to 2in. or more in diameter.

Milling.—This is a process much used on aluminium castings, and is one to which aluminium particularly lends itself.

The only special feature is the use of tools in which the teeth are set farther apart than usual to avoid clogging of the metal particles. A stream of soapy water directed on to the cutter will cancel any tendency for clogging by washing away the particles as they are produced.

Where a bright finish is required, paraffin should be used for lubricant. Ordinarily, however, when a mirror finish is not desired, milling is done dry, and high speeds are used.

Drilling.—The drill ordinarily used for aluminium is the standard twist type, although the use of flat drills is sometimes advocated.

The same precautions regarding keen edges apply to drills as to turning tools. Aluminium should be drilled at a high speed, but with only a moderate feed. The best peripheral speed is from 150ft. to 200ft. per minute, which means about 600 r.p.m. for a drill 1in. in diameter. With a 1in. drill the feed should be about 0·005in. per revolution, while for $\frac{1}{4}$in. drill the corresponding figure is 0·003in.

Paraffin is an excellent lubricant.

Grinding.—Both rough and precision grinding are extensively practised on aluminium. There is a large variety of grinding wheels available, and it is recommended that manufacturers of the wheels be consulted as to the best to use for any particular purpose.

Usually, the harder the work the softer the wheel employed, but with aluminium a soft or medium-soft wheel should be used, owing to the tendency for the metal to clog the wheel.

High speeds should be employed, up to 10,000ft. per minute for wheels of the carborundum type, and about 6000ft. per minute for wheels with shellac or other soft binders.

Rough grinding wheels may be kept from clogging by rubbing paraffin wax upon them. This prevents the adhesion of the metal particles without impairing the cutting ability of the wheel.

Filing.—For filing aluminium single-cut files always should be employed, as those of the double-cut type rapidly clog and become useless.

A quick method of cleaning clogged files is to dip them in strong caustic soda solution for a moment, after which the metal particles can be wiped off easily. A wash in cold water and a drying in sawdust should follow this treatment, or rusting is likely to take place.

Sawing.—A band saw of the wood-working type is excellent for such work as cutting off runners and risers from castings. The teeth should be large and the speed about 600ft. per minute. Band saws should be lubricated with oil or preferably tallow.

Hand cutting and trimming of thin sheet is easily done with a wood-worker's tenon saw and jack plane. Greater thicknesses of metal may be cut rapidly with a hack saw.

FORGING.

Though the forging of iron and steel has been practised since the earliest times, the application of this principle to the non-ferrous metals may be said to be a comparatively recent development. Many of the latter metals, however, particularly the light aluminium alloys, are well adapted for this process, and the combination of strength and lightness exhibited by forgings of this class makes them very valuable in many applications.

The forging process, as employed with aluminium alloys, is similar in principle to that used with steel, with differences as regards working temperature and die design. The preheating of the forging ingot is conducted in a closed muffle furnace, either heated by electricity or coal gas. Pyrometric control of the temperature is very desirable, as the range of temperature over which any aluminium alloy can be forged is very limited. This particularly applies to the harder alloys, such as duralumin. It is unsafe, for example, to heat duralumin to more than about 490 deg. Cent., otherwise there is a risk of spoiling the metal, while below about 470 deg. Cent. the metal becomes so hard that there is danger of cracking either of the dies or of the work. Other alloys have a somewhat wider range of forging temperature, and when conditions are such that the highest possible strength is not essential an alloy of the aluminium-zinc-copper class may be selected (No. 36, for example), which has a working temperature range of 350 deg. to 450 deg. Cent.

Metal required for forging in dies is most often supplied in the form of extruded or rolled bar, but occasionally it is necessary to start with a cast billet, in which case a preliminary cogging is necessary to work the metal down to about one-tenth of its original section. In this working down a series of light rapid blows is preferable to a few heavy blows, because aluminium alloys suffer more or less severely from hot shortness and are liable to shear under fierce treatment. In working down also the bar section should be kept square until the final stage in order to lessen the tendency for piping.

In the design of dies it must be remembered that aluminium alloys do not in general flow so readily as steel, so that sharp corners to depressions and rapid changes of section should be avoided where possible. Otherwise, it is desirable to use more than one set of dies, with a reheat between each, so that the final shape can be attained by easy stages. The same allowance for shrinkage should be made with aluminium as with steel, because although the coefficient of contraction is greater for aluminium, the working temperature is very much smaller.

Lubrication is sometimes avoided altogether with aluminium, but with this it is important that the die surface be well polished to prevent the sticking of the work. Where lubrication is necessary a satisfactory material is a paste of heavy engine oil mixed with flaked graphite.

The alloys principally used for forging are duralumin, "Y" alloys, the R.R. alloys, and the magnesium-silicide group, all of which attain their maximum strength after being subjected to a form of heat treatment. This treatment is carried out after the forging is completed. It is not essential to use such alloys in all cases, and for hub caps, door handles, and many other similar parts, ample strength is provided by a simple alloy, such as No. 36, which is not susceptible to heat treatment. Die pressings for such parts are superior to die castings in the same metals, since the structure of the metal is denser and more homogeneous.

* By permission of the British Aluminium Company, Ltd.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

ESCHER WYSS ENGINEERING WORKS, Ltd., have removed their offices to Terminal House, 52, Grosvenor-gardens, Westminster, S.W.1.

MR. E. C. GORDON ENGLAND has relinquished his position as aviation director of the Vacuum Oil Company, Ltd., upon being appointed joint managing director of General Aircraft, Ltd.

EXORS. OF JAMES MILLS, Ltd., Bredbury Steel Works and Rolling Mills, near Stockport, advise us that Mr. R. Catlow and Commander G. W. Wells have accepted an invitation to join the company's board of directors.

AKTIEBOLAGET NOMY, Ulvsunda, near Stockholm, Sweden, has opened an office in London under the title of the Nomy Block Bearing Agency, and has appointed Mr. G. E. Clare, A.M.I.M.E., manager. The address is 520, Grand Buildings, Trafalgar-square, London, W.C.2. Telephone, Whitehall 5952.

TUCK AND CO., Ltd., packing manufacturers, London, announce that owing to increased trade they have reorganised their sales staff. The number of representatives have been increased, and Mr. G. C. S. Tydeman, who has been a representative in London and the Provinces for several years, has been appointed sales manager.

ROYCE, Ltd., Loughborough, ask us to call our readers' attention to the fact that, as stated under this heading in our issue of January 11th, their Trafford Park Works and offices have been closed, and that they are now established at the Crane Works, Loughborough. By an error on our part we gave the old address in acknowledging the receipt of a catalogue from the firm in our issue of March 8th.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

MELDRUMS, Ltd., Timperley, have received an order for a large addition to their destructor plant at Haifa for the Haifa Municipality.

THE ENGLISH ELECTRIC COMPANY, Ltd., has received an order from the Great Western Railway Company for a 300/350 h.p., 50-ton Diesel-electric shunting locomotive. This locomotive will be built in conjunction with Hawthorn, Leslie and Co., Ltd., Newcastle-on-Tyne, who will supply the mechanical structure, the English Electric Company supplying the Diesel engine, generator, driving motors, and control equipment. The locomotive will be identical with the ten at present under construction for the London, Midland and Scottish Railway Company, the contract for which was placed with the English Electric Company at the beginning of this year.

THE SHARPAFORM CUTTER.—In connection with an article in our last issue entitled "The Sharpaform Cutter," we now learn that in addition to having the full manufacturing rights for this type of hob, David Brown and Sons (Huddersfield), Ltd., are also able to supply them directly to their customers, arrangements for this purpose having been made with Edgar Allen and Co., Ltd., of Sheffield.

INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' SECTION, LONDON.—Last Friday, March 22nd, there was held by the Graduates' Section, London, of the Institution of Mechanical Engineers, at the Connaught Rooms, Kingsway, a dinner and dance. It is hoped that this affair may be the first of a series of similar annual functions. Between fifty and sixty people took part, and the proceedings were honoured by the presence of the President, Colonel Davidson, who replied to the toast of "The Institution," proposed by Mr. B. W. Pendred, Chairman of the Section. Mr. Russell, Hon. Secretary of the Section, proposed the toast of the guests," and Mr. Tisdale, Chairman of the London Students of the Institution of Civil Engineers, responded. The speeches were all commendably short in order that the time for dancing might be as full as possible. A very pleasant function drew to a close at the approach of midnight.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The World's Steel Trades.

For the time being events have conspired to throw the world's iron and steel markets into confusion. The announcement of the increase in the British import duties has had repercussions beyond the British home market, and buyers in most overseas countries are inclined to suspend their purchases until there is some indication as to the attitude the Continental steel works will adopt. If foreign makers fulfil the threat they have often made of retaliating by a campaign of price cutting in all the export markets, then buyers in foreign countries may expect to benefit by low prices. On the other hand, if the Continent accepts the position created by the new duties as a basis for fresh negotiations with the British, then the result may be just the reverse, since the Import Duties Advisory Committee, in their recommendation, do not disguise their view that an arrangement between the British steel makers and the Cartel with regard to export markets would benefit both. The financial crisis in Belgium has also had a depressing influence upon business, since it is realised that if Belgium abandons the gold standard competition in the world's steel markets of the most severe kind would probably follow. In addition, the European Steel Cartel is suffering from internal dissensions, and although the trouble between the French and German steel makers with reference to the Saar production seems in a fair way to be settled there is a pronounced feeling of uneasiness. It is said that the German steel industry is prepared to face a dissolution of the Cartel and a return to unrestricted production and competition. The other parties to the Cartel are reported to have adopted a conciliatory attitude towards the German claims, but the whole Continental steel situation may be changed by the loss of the British market through the higher duties. For some time past the volume of business reaching the Continental steel works has not been sufficient to maintain the rate of operations ruling in the earlier part of this year and at the beginning of March the French, Belgian, and Luxemburg industries took steps to reduce their production. The American steel industry, of course, will be affected to only a limited extent by the alteration in the British duties. For the time being the industry seems to be working at a fairly level rate of between 46 per cent. and 50 per cent. of capacity. The sheet mills are busier at from 70 per cent. to 75 per cent.; but lately the volume of orders for constructional steel seems to have fallen off.

The Pig Iron Market.

Considering that rather quiet conditions have existed during the past week or two in most departments of the British iron and steel markets, the situation so far as pig iron is concerned must be considered fairly satisfactory. The demand for foundry iron consists principally of small orders, and a feature of the trade is that prompt delivery is almost invariably required. This points to consumers running on stocks, which leave little margin for eventualities. The time is approaching, also, when some of the contracts placed a few months ago will run out, and it is anticipated that their renewal will give more life to the market. Some consumers of Cleveland iron have large tonnages to accept against contracts; but there are others who will shortly have to enter the market. Business in Midland irons is maintained at a steady rate, but the producers express disappointment that the active conditions forecast for March have not developed. This is chiefly due to the fact that the Midland foundry trades, and particularly the light castings department, are not so busy as in the earlier part of the year, and the requirements of other consuming trades have not made sufficient headway to compensate for this loss. One of the brighter spots in the market for Midland pig iron is the progressive demand from the local engineering industries, which are well employed. In the Lancashire market fairly active conditions rule, and the consumption from all sources is estimated to be in excess of last year's average. Several contracts which have expired lately have been renewed, and if only the textile machinery manufacturers were busier the pig iron industry in this district would be in a good position. The situation in the Scottish pig iron market has not changed for some time. Deliveries are fairly good, and there is a steady demand which keeps the producers moderately busy. In the hematite market some contracts have been renewed, and inquiries relative to the renewal of others which are approaching completion have been circulated. Arrangements have been made with Italy by which that country will accept 80 per cent. of the imports of hematite based on a corresponding period last year, but it seems possible that the difficulty of remitting exchange may hinder deliveries.

The North-East Coast and Yorkshire.

It is too early to gauge the effect of the increase in the import duties, but on the basis of the prices for Continental and British steel which have been ruling for a long period, the new tariff would appear to make the sale of most descriptions of foreign steel impossible in the British market. Naturally, the works producing finished steel materials on the North-East Coast are sanguine that the advance in the duties will lead to a general expansion of home business, and with regard to export trade are prepared to await developments. For the past week or two the expectation of a higher tariff has diverted a considerable tonnage of orders for semis to the North-East Coast works, and these are now in a strong position with a good reserve of work on their books. Orders for heavy steel rails from the London, Midland and Scottish Railway and the London and North-Eastern Railway have now been allotted, the tonnage placed by the latter totalling 25,000 tons. This business will improve the situation at the rail mills, at which operations have been showing a tendency to slow down. At some works orders have been anticipated so that a proportion of the tonnage is already rolled, whilst at others the work has only just been put in hand. Some improvement has been noticeable lately in the request for plates, but the mills are by no means busy, and fresh orders would be welcome. The sheet makers seem to be more actively engaged. The home trade in this material has kept up well and is providing an outlet for a good tonnage. The export demand, which, until recently, was particularly poor, has shown signs of a revival, although the tonnage shipped abroad is still below normal. Busy conditions rule in the Yorkshire steel industry, and the Sheffield works in particular are maintaining a high rate of operations. The market requirements of acid billets have not expanded to the extent hoped for, but a good trade is passing in basic billets and the consumption of wire rods is on a heavy scale. The basic steel plants in the Sheffield district continue to produce at a record rate. Business in high-speed steel has slackened somewhat, but there is no relaxation in the demand for stainless steel. The re-rollers in the Sheffield district have experienced an improvement in the call for their products lately, and anticipate that the new duties will bring a further expansion in business.

The Midlands and South Wales.

Although the volume of business has not materially decreased, buyers in the Midlands have shown more hesitation in placing orders than for some time. The consuming industries, generally speaking, have good order books, but are not inclined to cover their forward requirements. This policy of hand-to-mouth buying is disliked by the steel makers, who also complain that a good many of the specifications that are now reaching them contain a considerable number of sizes which necessitates frequent roll changing and so adds to the production costs. The producers, however, do not seem to be greatly disturbed by the change in the market, as they believe the new duties will soon bring them more work. They point out, also, that in the early part of the year heavy contracts were placed which will keep them busy for some time. The steel sheet market, in contrast to some other departments, appears to be well occupied on the requirements of home consumers, but there has been no improvement worth speaking of in the export side of the trade. The re-rolling industry, too, has a fair volume of orders on the books, but new business has been rather scanty. Prices for small bars and strip are unaltered, and outside works still quote prices well below the Association figure. The needs of the constructional engineers do not appear to expand and this is rather surprising, since it is known that this industry is well employed. Business in plates during the past week has been steady, but the volume of orders reaching the works has scarcely fulfilled the manufacturers' anticipations of an improvement in the demand during the latter part of March. The request for steel for the collieries has been on a good scale, although the time is approaching when this seasonal demand usually tapers off. Most of the steel works producing this description of steel are busy. There has been no change in prices, the quotation for bridge rails being £7 10s. to £7 12s. 6d., whilst colliery arches are quoted at £8 15s. for heavy and £7 15s. for light. The South Wales iron and steel markets have developed some irregularity. The steel works producing heavy sections are moderately busy, but there has been some decline in the number of orders for sheet and tin-plate bars owing to the quieter demand for tin-plates. The ship repairing yards in South Wales have taken a fair amount of steel material lately, but constructional engineers have not shown much interest in the market.

Current Business.

A Government offer of one-third towards the cost, estimated at £750,000, of a deep-water quay on the north side of Tyne Dock, between Jarrow and South Shields, has been received by the Tyne Commission. The quay will provide berths for ships up to 30,000 tons. The Galloway Water Power Company has awarded the contract for the construction of the Loch Doon Dam in the Galloway water power scheme to Sir Robert McAlpine and Sons, Ltd. A contract for a steel screw tug for the Port of London Authority has been taken by Cochrane and Sons, Ltd., Selby. Hurst, Nelson and Co., Ltd., have secured an order for 750 pairs of wheels and axles for an Indian railway. Of the London and North-Eastern Railway Company's rail contracts for 1935, the following have been allotted:—Dorman, Long and Co., Ltd., 11,937 tons; Consett Iron Company, Ltd., 5244 tons; Cargo Fleet Iron Company, Ltd., 4737 tons; the Skinningrove Iron Company, Ltd., 3882 tons. The Great Western Railway Company has placed an order for a 300–350 h.p., 50-ton, Diesel-electric shunting locomotive with the English Electric Company, Ltd. The work will be carried out in conjunction with R. and W. Hawthorn, Leslie and Co., Ltd., Newcastle-on-Tyne, who will supply the mechanical structure. The following firms in Great Britain have shared in the orders placed by the Chinese Government Purchasing Commission in connection with structural work on the Hankow-Canton Railway:—Dorman, Long and Co., Ltd., Middlesbrough; Markham and Co., Ltd., Chesterfield; P. and W. Maclellan, Ltd., Glasgow; Alex. Findlay and Co., Ltd., Motherwell; and the Motherwell Bridge and Engineering Company, Ltd. The Admiralty has decided to place an order for a surveying ship for the 1934 programme with Wm. Denny and Brothers, Ltd., Dumbarton. The Department of Overseas Trade announces that the following contracts are open for tender:—Egypt, Ministry of the Interior, Municipalities and Local Commissions Section: supply and installation of electrically driven pumping plant (Cairo, April 17th); Lahore, North-Western Railway: copper tube and patching plates required for the year ending August 21st, 1936 (Lahore, April 15th); Singapore Municipality: electrically driven pumping plant, including pipes, castings, sluice valves, &c. (London or Singapore, April 23rd); Argentine State Railways Administration: Spring steel, steel for stays in round bars, perforated and plain carbon steel in rounds, squares and flats, tool steel and chrome-nickel steel (Buenos Aires, April 26th); six steel bridge spans for railway bridges (Buenos Aires, April 22nd); supply and delivery of three electric goods trolleys with loading capacity of 1500 to 2000 kgs. (Argentina, April 30th).

Copper.

The copper market has been stimulated by reports from America that the conference between the producers has resulted in an agreement. No official announcement, however, has been made, but it is understood that the production of the African and South American producers will be cut to the extent of 25 per cent. of the 1934 output, and that there may be a further reduction in a month or two. Exports from the United States are also to be limited to about 7000 tons per month, whilst the Canadian output, which is largely a by-product, is to be kept in stock in the form of matte, so that it will not appear in the statistics as refined copper available for the market. It is not surprising that the market responded to this news, particularly as consumers bought freely and their purchases were well distributed. A good business was transacted with buyers in Germany, France, and Switzerland, and only the difficulties of securing remittances from Italy prevented a large tonnage being disposed of to that country. There seems to be no difficulty in Italian consumers obtaining permission to import the metal, but apparently sellers have to wait a long time before their customers receive permission to pay them. So far, the fate of the proposal that a central organisation should be set up through which the copper produced in all countries would be marketed is not settled. The Belgians, it is said, were the only strong supporters of the scheme, and the copper market was definitely hostile. American statistics for February include for the first time the production of scrap. The total output of scrap and refined copper in America in that month was 38,000 tons, and for the rest of the world 91,000 tons. The American domestic consumption in February was 40,000 tons, and for the rest of the world 83,000 tons, whilst the stocks of refined copper in America at the end of the month were put at 328,000 tons, and elsewhere at 251,000 tons. The London standard market has responded to the better tone in electrolytic, and although there were some realisations, these were well absorbed.

The Tin Market.

One of the main objects of the tin restriction scheme was to prevent fluctuations in the market, but its success in this direction has not been very apparent of late. Towards the end of last week tin prices had dropped to £209 10s. for cash and £206 5s. for three months. From that point there has been a rapid upward movement. American buying made itself felt at the beginning of the week, and was undoubtedly largely responsible for the upward movement; but later on purchases from that quarter declined. A feature of the position is the high premiums which are charged for brands. This appears to be due to some extent to the ease with which important interests are able to secure a considerable part of the tin which comes on the Eastern market under the quota system, and naturally consumers who wish to buy certain brands of Eastern tin have to pay the premiums demanded. Interest is taken in the proposed amalgamation of the Banca and Billiton mines. It is understood that the intention is to consolidate the Dutch tin interests so that, should the present tin restriction scheme break down, the industry would be strong enough to look after itself. As, however, the present tin control agreement does not expire until the end of 1936, it would appear that the Dutch are considering precautionary measures some time in advance.

Lead and Spelter.

Active conditions rule in the lead market as a result of a report that a scheme that has received the approval of producers and consumers and the Committee of the London Metal Exchange will be placed before the Import Duties Advisory Committee, which is considering the position which has arisen as a result of the present 10 per cent. duty. This proposal was reported in these columns in our issue of March 15th, and seems to be designed to keep the price of lead at £13 per ton, a figure which the interests concerned appear to accept as reasonable. Under this plan the duty would be to sellers' account, and would be graded according to the price up to £13 per ton. Anticipations that this would result in practically a pegged price of £13 for a long time has resulted in consumers taking good quantities of lead and in a sharp advance in price. Recently Germany has bought lead and Russia also has been in the market, a good portion of the Mexican lead which arrived a little while ago having been sent to that country. . . . The improvement in the spelter market is largely the result of the sympathetic influence of the increase in the value of lead. There are indications, however, that the condition of the market is improving and that the stocks are being gradually reduced. Arrivals from the Continent this month have been on the small side, and there does not seem to be any expectation that further shipments will reach this country during the present month. The March Bulletin of the International Tin Research and Development Council gives the apparent world consumption of tin for the twelve months ending January 31st as 118,510 tons, compared with 126,446 tons for the previous year.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.: plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. (*D/d Teesside Area*) £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	3 8 6	3 2 0
No. 1	3 9 0	3 2 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/– rebate*)	3 7 6	—
Midlands—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 12 6	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/– rebate*)	3 7 6	—
N.W. Coast—		
Hematite Mixed Nos.	3 12 6 d/d Glasgow	
	4 0 6 „ Sheffield	
	4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. Yorks.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
Midlands—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	7 5 0 to 7 15 0	—
Scotland—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. Coast—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

London and the South—	Home. £ s. d.	Export. £ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 6	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	8 5 0
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 7 6 .. 7 15 0	0 to 8 5 0

STEEL (*continued*).

Glasgow and District—	Home. £ s. d.	Export. £ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 5 0
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	8 5 0

Ireland—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home. £ s. d.	Export. £ s. d.
Sheets.		
10-G. to 13-G., f.o.r.	9 0 0	8 15 0
14-G. to 20-G., d/d	10 5 0	9 0 0
21-G. to 24-G., d/d	10 10 0	9 5 0
25-G. to 27-G., d/d	11 2 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £16 12s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.

20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2 to 19/2.

Tin-plate Bars, d/d South Wales Works, £5 7s. 6d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 tons	5 15 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 10 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·70 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9¾d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £20[illegible]	
Cobalt	5/– to 5/6d. per lb.	

NON-FERROUS METALS.

Official Prices, March 27th.

Copper—		
Cash	£30 2 6 to £30 3 9	
Three months	£30 11 3 to £30 12 6	
Electrolytic	£33 5 0 to £33 15 0	
Best Selected Ingots, d/d Birmingham	£33 5 0	
Sheets, Hot Rolled	£60 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	9½d.	9½d.
„ Brazed (basis)	9½d.	9½d.
Brass—		
Ingots, 70/30, d/d Birmingham	£26 0 0 to £28 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	8¾d.	8¾d.
„ Brazed	10¾d.	10¾d.
Tin—		
Cash	£216 5 0 to £216 15 0	
Three months	£212 10 0 to £212 15 0	
Lead: Cash and Forward	£12 2 6	
Spelter	£13 2 6 to £13 0 0	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
f.o.b. Grangemouth)—Navigation Unscreened	13/– to 13/6
„ Glasgow—Ell	16/6
„ „ Splint	17/6
Ayrshire—	
(f.o.b. Ports)—Steam	14/– to 14/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Prime Steam	13/6 to 14/–
Unscreened Navigation	12/6 to 13/–
Lothians—	
(f.o.b. Leith)—Hartley Prime	14/– to 14/3
Secondary Steam	13/– to 13/6

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	15/– to 17/6
Northumberland, Newcastle—	
Blyth Best	14/3 to 14/9
„ Second	13/3
„ Best Small	10/6 to 11/–
Unscreened	12/6 to 13/6
Durham—	
Best Gas	14/8
Foundry Coke	19/– to 20/–

Sheffield—	Inland.
Best Hand-picked Branch	24/– to 26/– —
South Yorkshire Best	21/– to 23/– —
South Yorkshire Seconds	17/6 to 19/– —
Rough Slacks	8/– to 9/– —
Nutty Slacks	7/– to 8/6 —

SOUTH WALES.

Cardiff— Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	24/– to 37/6
Furnace Coke	19/– to 21/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	34/– to 40/–
Machine-made Cobbles	41/– to 51/–
Nuts	40/– to 50/–
Beans	25/– to 30/–
Peas	19/– to 22/6
Rubbly Culm	10/6 to 11/–
Steam Coals:	
Large	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Steel Dilemma.

THE raising of import duties on steel entering Great Britain has seriously perturbed French steel makers, who had hoped that this action would have been suspended as the result of the conference at Cannes, when it was decided to resume negotiations to bring British steel makers into the Cartel. The new duties are regarded as having changed entirely the international steel situation. They are supposed to be aimed at the threatened devaluation of the belga, and the French are making the most of this protective measure as an argument to support their claim that there is nothing to be gained by leaving the gold standard. The new duties are also believed to imply that British steel makers are little disposed to negotiate further on the terms offered them to join the Cartel, or that they have confidence in the ability of Continental makers to prevent it from foundering on the rock of difficulties existing between France and Germany over the claim of the latter country for a larger quota of foreign trade as compensation for the loss of the French market for Saar products. Last week-end meetings were held in Paris between French and German steel makers to discuss the German claim. It cannot be accepted by the French at a time when the home demand has fallen to so low an ebb, but there was a possibility of reaching a compromise, which, however, could not be found and another meeting is being held this week to discuss matters further. If the Germans cannot obtain satisfaction, it is assumed that they will extend their barter agreements with other countries, in which event German steel exports will be placed beyond control of the Cartel. It is argued that German makers have no interest in letting prices collapse through the failure of the International Steel Union, and that they will respond to efforts being made to effect a compromise in order to save a difficult situation, which is not made easier by the general feeling of uneasiness over possibilities of currency upheaval. Meanwhile the reaction produced by the new British imports duties is so strong that metallurgical groups sent a delegation to the President of the Council to insist on urgent measures being taken to obtain from the British Government a withdrawal of the additional duties.

Trade Exchanges.

The causes responsible for the decline of foreign trade, and the failure of commercial agreements to give practical results under conditions that place obstacles in the way of trade development, have nullified all attempts to promote foreign exchanges. Commercial and industrial groups and the Ministry of Commerce elaborated plans which had to be scrapped, and new schemes are being evolved tending to a settled policy that aims at organising an Empire trade and expanding commercial relations abroad. It is necessarily kept within narrow limits by currency disparities and fluctuations, and no general plan can be laid down until currencies are stabilised; but principles are accepted that will enable this country to fall into line with any movement that may be favourable to trade recovery. The French Union of Exporting Industries is now making a further effort to put in motion a plan of action. That body represents all manufacturers and producers throughout the country depending upon an export trade, and its tendencies have always been in favour of offering the greatest facilities for foreign trade expansion; but it has now necessarily to take into account the difficulties of carrying on business with foreign countries, and its plan therefore provides for a widening of quotas and means for promoting trade amongst gold countries. Import quotas are now regarded by all, except those manufacturers who cannot exist without them, as necessary evils which cannot be dispensed with in present circumstances. They can be widened to open up reciprocal trade, and they will lose their restrictive character when it is no longer necessary to protect home industries from an invasion of cheap goods. Until then the Union of Exporting Industries has fallen into line with the general desire to promote closer relations amongst the gold countries. So far efforts to develop that trade have failed, partly because a similarity of goods and products restricts the possibility of any considerable increase of exchanges and, more particularly, because the most-favoured-nation clause in treaties with other countries precludes preferential treatment with gold countries. If, however, such treatment could be accorded it is believed that trade could be substantially improved within that group, and the Union of Exporting Industries asks the Government to convene an international conference with the object of obtaining partial release from the most-favoured-treatment obligations in order to meet this special case. Another part of its plan is to institute "an organisation of triangular exchanges between overseas territories, foreign countries, and the Mother Country." This means that the Imperial Conference finds itself confronted with difficulties arising out of the inability of Protectorates and mandated territories to offer preferential treatment to France, and this is specially the case in Morocco, where French capital has been lavishly spent and the country finds it more profitable to trade with the sterling group of countries than with France. The idea, apparently, is to offer concessions to other countries in return for an abandonment of their commercial claims on the Protectorates, so that all the French territories will form one economic unit. These plans do not offer an early possible solution of an increasingly urgent problem.

Exhibition Inventions.

Amongst the attractions proposed for the Paris Exhibition of 1937 the most startling is that devised by Monsieur Bernard Debos, who has invented what he calls a "meteorological tube." This tube is a reinforced concrete structure in the form of a funnel, 2000ft. high, with an opening 165ft. diameter at the base and 460ft. across the top. This height will allow of a barometric depression of 4 cm. It will, the inventor declares, produce abundant rain as required in arid territories, besides recuperating atmospheric electricity.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator printed are in italics.

When an abridgment is not illustrated the Specification is without drawings.

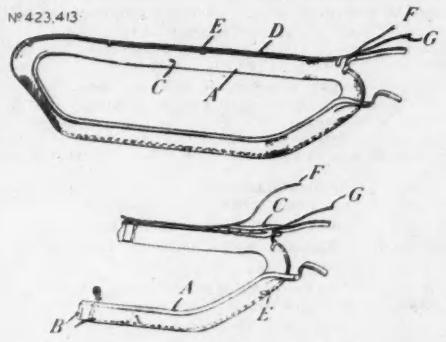
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

423,413. June 1st, 1934.—ELECTRICAL INSULATION, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.

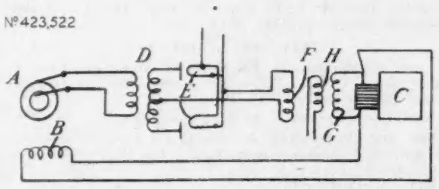
This invention is concerned with a means for preserving electrically insulated parts, such as electrical coils, from deterioration due to ageing, storage, &c. The illustrations show a field coil A of a motor which is constructed in the usual manner, and is insulated with an oil varnished tape insulation B of the usual kind. In order to protect this insulation from deterioration between the time it is put on the coil and the time the latter is actually assembled as part of a motor, it is provided with a coat of cellulose acetate C formed thereon by dipping the coil into a



suitable bath of the composition. The coat of cellulose acetate is easily applied and is moisture-proof in character. It effectively seals the insulation proper from the air and completely protects the same indefinitely, since it conforms to the configuration of the insulated part. It is easily removed as an entity and in order to facilitate its removal a string, wire, or cord D is first fastened, as by tape fasteners E, on to the insulation proper before the coil is dipped in the cellulose acetate solution. It is obvious that the free ends F and G of the string D should be left outside of the cellulose acetate for a distance sufficient to enable a person removing the film or covering G to grasp one of the ends, say, end F, and pull it against the surface of the film to tear it open.—*January 31st*, 1935.

423,522. August 4th, 1933.—REGULATING DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2; Harold Orchard, of 30, Claremont-road, Rugby; and John Alan Jaffrey, of 29D, Regent-street, Rugby.

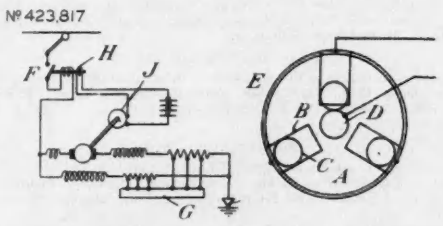
When D.C. or A.C. generators are driven by a comparatively slow-running prime mover, such as a water wheel, the exciters are fairly large machines, and if a vibrating contact regulator be used, it does not act quickly enough at high voltages. An object of this invention is to provide a system of voltage regula-



tion which, while being less expensive than those at present in use, will give a quicker response for super-excitation. In the diagram, A represents an alternator having a field winding B excited from an exciter C. The primary of a transformer D is connected across the alternator terminals. The current from the secondary of the transformer is rectified by means of the valves E, and supplied to the differential field winding F of the exciter C. The exciter is also provided with a shunt field winding G, and a third winding H, which is separately excited from any convenient source.—*February 4th*, 1935.

423,817. November 20th, 1933.—ARRANGEMENTS FOR ELECTRIC COMMUTATOR MOTORS, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and Francis Munton Jackson, of The General Electric Company, Ltd., Engineering Works, Witton, Birmingham.

According to this invention, in a protective arrangement for an electric commutator motor, the latter is adapted automatically to be cut out at one value of current overload while it is rotating at appreciable speed and at a lower value of overload while it is stationary. The switch comprises a disc

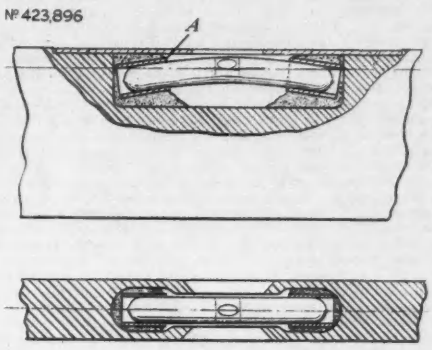


A of insulating material, on which are radially disposed three metal cylinders B, each containing a metal ball C. The open ends of the cylinders terminate adjacent to the spindle D, on which the disc A rotates, the spacing being such that the balls cannot escape. When the disc is stationary or at very low speeds, there is always one ball in contact with the spindle D, and the circuit is thus completed from the cylinder, through the ball and the spindle, and through a slip ring E to which the cylinders are connected. Brush-holders and terminals are mounted on a cover for the centrifugal switch, the brushes engaging the shaft D and the slip ring E respectively. Thus, the circuit breaker F may be set normally to operate at 400 ampères. When, however, the motor is stationary and the controller G is in an operative position, the addition coil H is effective and the circuit breaker is set to trip open with a value of current in the motor circuit of 200 ampères. Directly the armature speed reaches a predetermined very low value, however, the centrifugal switch J operates and renders the additional coil ineffective.—*February 8th*, 1935.

MEASURING AND TESTING INSTRUMENTS.

423,896. January 26th, 1934.—SPIRIT LEVELS, W. Marples and Sons, Ltd., Westville-terrace, Sheffield, J. and A. O'Connor-Fenton.

It is complained in this specification that the usual method of

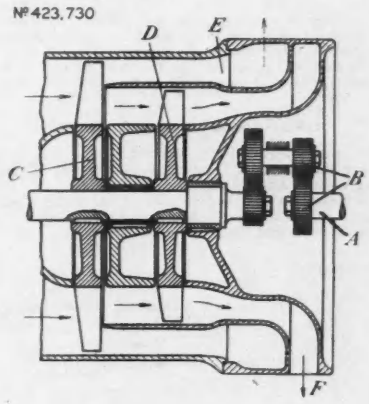


mounting the glass tube of a spirit level by means of plaster of Paris gives rise to objectionable strains in the glass. The inventor consequently arranges a resilient sleeve of rubber A between the glass and the plaster setting.—*February 11th*, 1935.

PUMPING AND BLOWING MACHINERY.

423,730. October 19th, 1934.—MULTIPLE-STAGE BLOWERS, Siemens und Halske Aktiengesellschaft, Berlin-Siemensstadt, Germany.

This invention is concerned with blowers used for cooling and scavenging, or supercharging internal combustion engines. The blower is driven from the crank shaft A of the main engine,

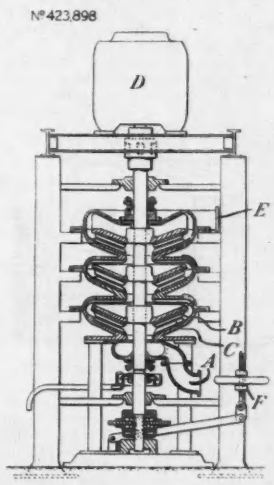


through the gearing B, and is equipped with two impellers C and D. The first impeller C is of greater diameter than the second, and sends a current of air by the passage E to the cooling system. It also delivers air to the second impeller D, which raises the pressure and delivers the air for scavenging purposes by the passage F.—*February 6th*, 1935.

CRUSHING AND GRINDING.

423,898. February 6th, 1934.—GRINDING MACHINES FOR PAPER PULP, F. Lord, 26, Astbury-street, and A. C. Wilby, jun., 5, Johnson-street, Radcliffe, Lancaster.

This grinding machine for paper pulp has three or more stages, through which the pulp is forced upwardly from the



inlet A. The grinding is effected between blades on the rotary cones B and the fixed blades C. The rotating cones are driven by the motor D. The outlet for the ground pulp is shown at E. The clearance between the fixed and moving blades can be adjusted by the gear F.—*February 11th*, 1935.

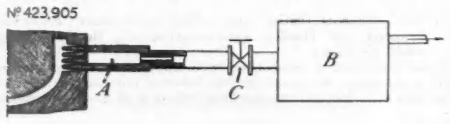
METALLURGY.

423,489. September 20th, 1934.—CASTING OF ARTICLES TO BE HARDENED BY NITROGENISATION, *Nitralloy, Ltd., Norris Deakin Buildings, King-street, Sheffield.*

This invention relates to casting ferrous alloys, such as irons and steels, of the type adapted to be hardened by nitrogenisation and containing aluminium in quantities not exceeding about 5 per cent. by weight and preferably also chromium in quanties not exceeding 8 per cent. by weight. In making castings of iron and steel alloys of this type it is found that the aluminium oxidises very readily and the presence of the resultant oxide in the molten alloy or the casting is very objectionable. It makes the slag sticky and viscous, for which reasons it is very difficult and, in some instances, impossible to pour the metal, particularly where sand moulds are employed. Furthermore, portions of the aluminium oxide are retained or become entrapped within the casting, and these produce defects. Such a defect of a size slightly greater than that of a pinhole may give rise to a spongy area if the steel is hardened by nitrogenisation, whereas, if the material is not so treated, it might be otherwise entirely acceptable. For these reasons it is very important that the aluminium oxide be removed. The invention provides a method of casting a ferrous alloy of the type specified, which includes the step of removing the aluminium oxide from the alloy, by adding a solvent which dissolves the oxide or chemically combines with it so that it may be removed in its combined or dissolved form with the slag. Aluminium is known to be amphoteric in character—that is, it can appear both in the base and in the acid radical. Hence, any chemical which will react with aluminium oxide to form a salt, with the aluminium in either the base or acid radical, may be used to eliminate the oxide from the bath. Fluorides, in general, will dissolve or react with aluminium oxide in the manner described. Of these, the most important are the fluorides of sodium, potassium, calcium, barium, and the double fluorides of aluminium and sodium. Compounds of the metals of the alkali and alkaline earth groups in general are also suitable fluxes or solvents for the oxide. The most important of these are sodium oxide, potassium oxide, barium oxide, sodium carbonate, potassium carbonate, barium carbonate, sodium hydroxide, and potassium hydroxide. Naturally, any desired combination of the foregoing solvents may likewise be employed.—*February 1st*, 1935.

423,905. July 2nd, 1934.—CASTING LIGHT METALS AND ALLOYS, Fonderie Bruneau Frères, 21, rue Rollin, Paris, France.

This casting process is especially applicable to the production of cylinder heads for air-cooled internal combustion engines, or other castings of a similar character. The parts of the

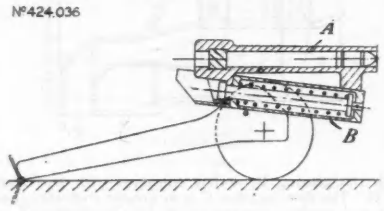


mould forming the cooling fins, for instance, are connected by fine passages with a chamber A. At the moment of casting this chamber is put in communication with a vessel B, in which a vacuum has been produced, by the opening of a cock C, so as to evacuate air and gases from the mould.—*February 11th*, 1935.

ORDNANCE AND ARMOUR.

424,036. March 24th, 1934.—RECOIL GEAR FOR GUNS, F. Mayer-Mallenau, Dr. Ludwig Rieger-Strasse 4, Mödling, near Vienna, Austria.

This invention is intended to prevent an artillery gun from "bucking" at the moment of firing, and thus spoiling the aim. The gun barrel A and the recoil cylinder B are set at a slight

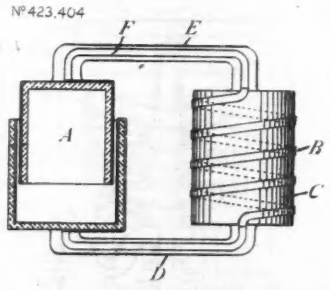


angle one to the other. It is obvious that the gun will rise, with respect to the horizon of the recoil cylinder, regardless of the elevation, and will produce a reaction that will tend to counteract the torque causing the buck. The specification includes the necessary mathematics for determining the angle between the gun barrel and the recoil cylinder.—*February 13th*, 1935.

MISCELLANEOUS.

423,404. April 19th, 1934.—OSCILLATORY ELECTRIC CIRCUITS, Telefunken Gesselschaft für drahtlose Telegraphie m.b.H., a German company, of 12, Hallesches Ufer, Berlin, S.W.11, Germany.

According to this invention the components of an oscillatory circuit, such as the coils and condensers, each of which is of itself immune from variation due to temperature change and having some degree of mutual coupling, are mounted on a common support having a negligible coefficient of thermal expansion. A denotes a condenser, which consists of a carrier of a ceramic material provided with metal layers or coatings.



B is a self-induction coil, the current-carrying winding of which is also a coating or layer on a ceramic body C. The two oscillatory elements which, in themselves, are independent of temperature variation, are connected together by supports D and E, made of a material having a negligible coefficient of thermal expansion, and which may be a suitable metallic alloy, such as is known under the registered trade mark Invar, or the supports may comprise a ceramic material having a metal coating or layer F of suitable width applied thereto. This metal coating F serves for electrically connecting the oscillatory elements.—*January 31st*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Discussion, "The Bend Test and its Value as a Guide to Ductility," Mr. L. W. Schuster. 6 p.m.

INST. OF MECHANICAL ENGINEERS: EAST MIDLANDS BRANCH.—Technical College, Lincoln. "Stainless Steels," Mr. G. E. Wolstenholme. 9 p.m.

INST. OF MECHANICAL ENGINEERS: WESTERN BRANCH.—Merchant Venturers' Technical College, Bristol. "Some Factors in Maintenance Engineering," Mr. A. J. Bowron. 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Notes on the Development of Motor Fishing Vessels in Scotland," Mr. K. W. Willans. 7.30 p.m.

MANCHESTER METALLURGICAL SOC.—Joint meeting with Inst. of Chemical Engineers. Visit to the Partington Gasworks of the Manchester Corporation, 2.15 p.m. Joule Room, Engineers' Club, Albert-square, Manchester. "Materials of Construction," Mr. J. McKillop, 6.30 p.m. Informal dinner, 8.15 p.m.

ROYAL AERONAUTICAL SOC.—This meeting is cancelled.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. Discourse, "The Neutron and Radio-active Transformations," Lord Rutherford. 9 p.m.

TO-DAY AND SATURDAY, MARCH 30TH.

FARADAY SOC.—At Imperial College of Science and Technology, S. Kensington, S.W.7. General discussion on "The Structure of Metallic Coatings, Films, and Surfaces." Daily sessions, 10 a.m. and 2.30 p.m. For details of papers see page 195.

INST. OF PHYSICS.—Manchester. Conference on Industrial Physics. For provisional programme see page 210.

TO-DAY TO THURSDAY, APRIL 18TH.

IDEAL HOME EXHIBITION.—Olympia, W. Open daily.

SATURDAY, MARCH 30TH.

ROYAL INST. OF GREAT BRITAIN.—21, Albemarle-street, W.1. "Electro-magnetic Radiations," Lord Rutherford. 3 p.m.

MONDAY, APRIL 1ST.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "The Road-carrier for Railway Trucks: A Transport Problem and its Solution," Dr. Hans Culemeyer. 5.15 for 6 p.m.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, W.C.2. Informal meeting. Mr. H. Brierley and Mr. A. F. W. Richards will open discussion on "Change-over." 6 p.m.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND CENTRE.—James Watt Memorial Inst., Birmingham. Informal meeting. Mr. T. E. Goldup will open discussion on "The Future Development of Thermionic Receiving Valves." 6.15 for 7 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Rubber Latex as a Manufacturing Material" (second paper), Dr. D. F. Twiss. 8 p.m.

SOC. OF CHEMICAL INDUSTRY: LONDON SECTION.—At the Chemical Society's Rooms, Burlington House, W.1. "Corrosion-resisting Non-ferrous Alloys," Dr. Harold Moore. 8 p.m.

TUESDAY, APRIL 2ND.

INST. OF AUTOMOBILE ENGINEERS.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. "Oil Engines for Road Transport," Mr. H. O. Farmer. 7.45 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Discussion, "Remedial Measures on the Arapuni Hydro-electric Scheme of Power Development on the Waikato River, New Zealand," Mr. F. W. Furkert; and "The Pykara Hydro-electric Development," Mr. M. G. Platts. 6 p.m.

WEDNESDAY, APRIL 3RD.

INST. OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Savoy-place, W.C.2. "The Non-linear Theory of the Maintenance of Oscillations," Dr. P. le Corbeiller. 6 p.m.

ROYAL SOC. OF ARTS.—Meeting postponed.

SOC. OF ENGINEERS.—At the Royal Institution of Great Britain, 21, Albemarle-street, W.1. "The Theoretical Strength of Materials and their Practical Weakness," Sir William Bragg, F.R.S. 5.30 for 6 p.m.

SOC. OF GLASS TECHNOLOGY: LONDON SECTION.—Visit to Science Museum, South Kensington, S.W.7. 7.30 p.m.

THURSDAY, APRIL 4TH.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOC.—Visit to sewage purification works at Coleshill, 2.45 p.m., and Hams Hall power station, 4 p.m. Leave by motor coach, White Horse Hotel, Congreve-street, Birmingham, 2.10 p.m.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C.2. Faraday Lecture, "Electricity in the Life of To-day," Prof. Dr. E. W. Marchant. 5.30 for 6 p.m.

FRIDAY, APRIL 5TH.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. Discussion, "The Use of Needle Roller Bearings." Opening speaker, Mr. C. G. H. Richardson. 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Informal meeting. "Some Aspects of Cement Testing," Mr. R. P. Mears. 7.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—At Mining Inst., Newcastle-upon-Tyne. "Ocean Transportation of Petroleum in Bulk," Mr. Robert F. Hand. 6 p.m.

RAILWAY CLUB.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. "Railway Stations and Architecture," Mr. R. M. Robbins. 7.30 p.m.

SATURDAY, APRIL 6TH.

INST. OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—At Engineers' Club, Manchester. Annual general meeting. Paper, "Some Notes on the Production of Steel Castings," Mr. J. E. Mercer. 3.30 p.m.

MONDAY, APRIL 8TH.

INST. OF CIVIL ENGINEERS: BELFAST AND DISTRICT ASSOC.—Queen's University, Belfast. Institution Lecture to Students, "Modern Methods and Plant for Excavation," Sir Henry Japp. 6.30 p.m.

STEPHENSON LOCOMOTIVE SOC.—King's Cross Station, N.1. "The Production of a Locomotive from Preliminary Schemes to the Trial Run," Mr. Eric Forge. 6.30 p.m.

TUESDAY, APRIL 9TH.

INST. OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "Brittleness in Engineering Materials," Mr. W. E. Lewis. 7.30 p.m.

INST. OF MARINE ENGINEERS.—85/88, The Minories, E.C.3. "Modern Marine Condensing Plants and Feed Systems," Mr. H. Hillier. 6 p.m.

MANCHESTER GEOLOGICAL AND MINING SOC.—Visit to works of the Lancashire Steel Corporation, Irlam, near Manchester. 2.45 p.m.

WEDNESDAY, APRIL 10TH.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Informal meeting. Discussion, "The Economic Outlook for Engineering," Mr. J. L. Hodgson. 6 p.m.

INST. OF FUEL.—At Chemical Soc., Burlington House, W.1. "Processing of Solid and Liquid Hydrocarbons in the Coal, Oil and Gas Industries, with reference to Developments at Corby," Mr. Alfred Fisher. 6 p.m.

INST. OF NAVAL ARCHITECTS.—Grand Hall, Connaught Rooms, Great Queen-street, W.C.2. Annual dinner. 7.30 p.m.

LIVERPOOL ENGINEERING SOC.—9, The Temple, 24, Dale-street, Liverpool. Annual general meeting. 6.30 p.m.

WEDNESDAY TO FRIDAY, APRIL 10TH TO APRIL 12TH.

INST. OF NAVAL ARCHITECTS.—At Royal Soc. of Arts, John-street, Adelphi. Annual general meetings. For programme see page 337.

THURSDAY, APRIL 11TH.

INST. OF ELECTRICAL ENGINEERS.—Savoy-place, W.C.2. "The Droitwich Broadcasting Station," Messrs. N. Ashbridge, H. Bishop, and B. N. MacLarty. 6 p.m.

INST. OF METALS: LONDON LOCAL SECTION.—At Rooms of Soc. of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. Annual general meeting. Mr. C. Dresser will open discussion on "The Use of Significance of Specifications." 7.30 p.m.

FRIDAY, APRIL 12TH.

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS.—Savoy-place, W.C.2. Address by the President, Prof. W. M. Thornton. 6.30 for 7 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Extra general meeting. Discussion, "Aerodynamical Research and Hydraulic Practice," Mr. A. Fage. 6 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Art and Industry in Scandinavia," Mr. C. H. G. Aston. 7.30 p.m.

MONDAY, APRIL 15TH.

INST. OF CIVIL ENGINEERS: BELFAST AND DISTRICT ASSOC.—Queen's University, Belfast. "The Preparation of Estimates for Public Works," Mr. F. C. Fforde. 6.30 p.m.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "The New Bridge over the Little Belt," Dr. Ing. e.h.o. Erlinghagen. 5.15 for 6 p.m.

ROYAL AERONAUTICAL SOC.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. "Commercial Aircraft," Captain C. de Havilland. 6.30 p.m.

WEDNESDAY, APRIL 17TH.

INST. OF LOCOMOTIVE ENGINEERS.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. General meeting. 6 p.m.

THURSDAY, APRIL 18TH,

INST. OF MARINE ENGINEERS.—85/88, The Minories, E.C.3. Junior Section debate, "Should the Marine Engineer have a University Training?" For, Mr. K. P. Harman; against, Mr. H. R. Tyrrell. 7 p.m.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. Annual general meeting. Paper, "Piling Foundations," Mr. G. R. Pimm. 7 p.m.

LAUNCHES AND TRIAL TRIPS.

CALABAR, motor vessel; built by Harland and Wolff, Ltd., to the order of the Elder Dempster Line, Ltd.; dimensions, 256ft. 6in. by 41ft.; to carry cargo and passengers. Diesel engines, Harland-B. and W. trunk piston type; constructed by the builders; trial trip, recent.

ONGER, drag and cutter suction hopper dredger; built by Wm. Simons and Co., Ltd., to the order of the Crown Agents for the Colonies on behalf of the Basrah Port Directorate for work at Basrah, Iraq. Engines, triple expansion; launch, March 19th.

SHEPPERTON FERRY, twin-screw train ferry steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Southern Railway Company; dimensions, 360ft. long; to carry trains between Dover and Dunkirk; trial trip, March 20th.

HEL, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Messrs. Zegluga, Polska, S.A., of Gdynia; dimensions, 243ft. by 36ft. 6in.; to carry cargo. Steam engines of compound reciprocating type, in conjunction with low-pressure exhaust turbine; constructed by the builders; launch, March 21st.

A GLASS CONVENTION.—The British glass industry will hold its fourth Convention at Folkestone in May, from the 16th to the 18th. Mr. Geoffrey L. Pilkington will preside, and there will be addresses and discussions by well-known authorities on such questions as design in the glass industry, uniformity and quality of products, planning, and the commercial importance of furnace design.

THE LATE MR. W. H. WOOD.—We regret to have to announce the sudden death of Mr. W. H. Wood, a co-director of the Constructional Engineering Company, Ltd., Titan Works, Birmingham, 12, at the age of eighty years. Following a wide engineering experience of some forty-five years, Mr. Wood joined Mr. D. H. Wood in that business shortly after its commencement in 1911, and was actively and intimately connected with its growth and progress.

THE REFRACTORIES ASSOCIATION OF GREAT BRITAIN.—An attendance of more than 150 members and guests at the sixteenth annual banquet of the Refractories Association of Great Britain, which was held at Grosvenor House on Wednesday, March 20th, was itself a testimony to the revival of prosperity in the British refractories industry, which has been largely influenced by the work of the Association. In the regretted absence of Mr. William Lomas, of Sheffield, who is ninety-four years of age, the chair was taken by his son, Mr. Alex. Lomas, who installed the new President, Mr. F. Metcalfe Fisher. The Secretary of the Association, Mr. W. J. Rees, M.Sc., F.I.C., efficiently performed the duties of honorary toastmaster. A feature of the evening was the making of a film for the retiring President and absent members, which was ably carried out by the Convener, Mr. Frank S. Russell, and his staff. The toast of "The Guests" was proposed by Mr. Herbert Wragg, and Mr. W. Whytehead Boulton replied. In proposing the toast of "His Majesty's Government," Sir Ronald Matthews dealt with the international situation, and paid a tribute to the help given to the industries of the country by the policy of the Government. In responding to the toast, Mr. Louis Smith said that Sheffield and the Sheffield University had set a world example by the amount of research which had been carried out in the iron and steel and allied industries. The toast of "The Refractories Industries and the Association" was briefly proposed by Baillie Phillip McDevitt, and Mr. H. J. C. Johnson replied. After the speeches there was a cabaret performance, and the evening, of varied interest, was an enjoyable one in every way